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Notes on the Herpetofauna of Western Mexico 22: A New Food Item for the Mexican Leaf Frog, *Agalychnis dacnicolor*: The Tarantula *Bonnetina* sp. (Mexican Blue Beauty)

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Abstract

During the course of a survey conducted in the municipality of Aguililla in the state of Michoacan, Mexico, we observed a Mexican leaf frog (*Agalychnis dacnicolor*) prey upon a tarantula (*Bonnetina* sp.). Predator-prey interactions between various spider and frog species have been documented many times—a phenomenon that day by day grows as more researchers are out in the field.

Resumen

En un recorrido realizado en el municipio de Aguililla estado de Michoacán, México, aquí documentamos el consumo de un alimento en la dieta de la Rana de Árbol Mexicana. Esta interacción depredador-presa ha sido documentada en muchas ocasiones en diferentes especies de araña-ranas. Un fenómeno que día a día crece como más personas en el campo.

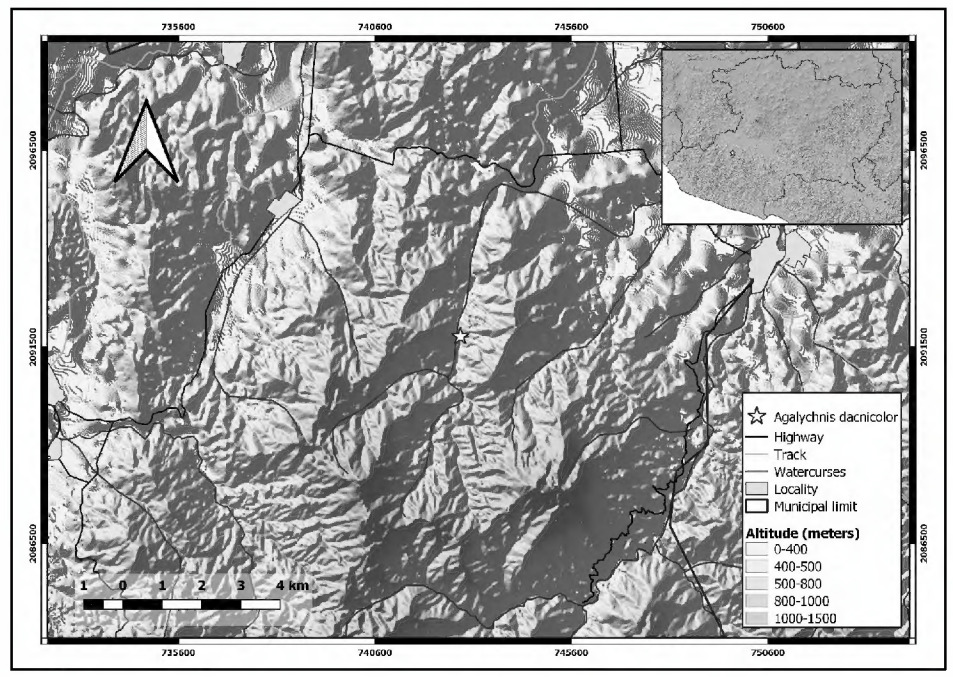
On 4 April 2018 at 11;00 h, during a herpetofauna survey in the municipality of Aguililla in the state of Michoacán, Mexico, we encountered an adult *Agalychnis dacnicolor* (Mexican leaf frog / *rana de árbol Mexicana*) perched on an *Enterolobium cyclocarpum* (elephant-ear tree / árbol de Guanacaste) consuming a male tarantula (*Bonnetina* sp.). This is rare observation—more often tarantulas are found feeding on frogs. The event took place at (18°54'14"N, 102°41'43"W; WGS84; elevation 459 m) in Tropical Deciduous Forest.

Study Site

Aguililla is one of 113 municipalities that make up the state of Michoacan. It is located in the southwest of the state and about 290 km southwest of the city of Morelia. This municipality has an surface area of 1406.39 km^2, about 2.39% of the state's territory. As of the census of population and housing of 2005, the municipality had 16,159 inhabitants.

Due to the complicated terrain of the municipality and its geographical location, elevation may go from 260 to 2880 masl within a distance of 50 km. It has one of the most diverse floras in the state. We can find many different types of vegetation or forest: Oyamel, Ayarin, Cedar, Mountain Cloud, Pine, Pine-Oak. Disturbed Forest. Oak, Juniper, Tropical Semideciduous, Tropical Deciduous Forest. Thorny Deciduous Forest, Gallery Forest, Nopalera. Izotal. Gallery vegetation, Savannah, Mezquital, Grasslands, River and Introduced grasslands.

Agalychnis dacnicolor (Mexican leaf frog / *rana de árbol Mexicana*) preying an adult male tarantula (*Bonnetina* sp.). Photograph by José Manuel Valencia-Valdez.



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A female *Bonnetina* sp. from the area. Photograph by José Manuel Valencia-Valdez.

Tropical Deciduous Forest where the event took place. Photograph by José Manuel Valencia-Valdez.

Background

It is not the purpose of this note to provide a complete review of the documented articles on the subject, but rather to mention a few examples of the strange, but very common trophic interactions between spiders and frogs.

Amphibians preying on arachnids

García-Ramírez et al. (2015) studied the diets of 15 species of the genus *Pristimantis* (robber frogs) from the Andes in western Colombia. They identified 499 prey items from stomach and intestinal contents of 154 specimens. Ten of the 15 frog species were found with at least one item of Araneae, Coleoptera and Tipulidae. Their results suggest that most of the frog species studied are generalists, foraging opportunistically on dipterans, arachnids [example: giant harvestman (*Vonones* sp.)], collembolans, coleopterans and hymenopterans.

Loc-Barragán et al. (2017) document finding a young *Lithobates forreri* (Forrer's leopard frog) on 11 May 2017 foraging along the edge of a pool of water in a dry streambed in tropical deciduous forest at Rancho Ecoaldea, Ojo de Cielo, San Blas, Nayarit, Mexico. The frog detected a moving spider, which also appeared to be foraging along the rocks surrounding the puddle, and proceeded to prey on the spider. Soon after capture the frog regurgitated its prey, which was identified as a fishing spider, *Dolomedes* sp.

Arachnids preying on amphibians

Arthropods, including spiders, are potential predators of reptiles and amphibians, with numerous reports in the literature as documented below. Predation is one of the main causes of mortality in natural amphibian populations and may occur in any stage of the life cycle (Zug et al., 2001). Many studies report spiders preying on frogs, and this could be related to the preferentially nocturnal habits of these groups (Maffei et al., 2010). Anuran eggs, tadpoles, and post-metamorphic individuals are known to be preyed upon by vertebrates, invertebrates, and even carnivorous plants. Spiders may play an important role (Toledo, 2005; Toledo et al., 2007; Barej et al., 2009; Aguilar-López et al., 2014; Calzada-Arciniega, 2014; García-Vinalay and Pineda, 2017), exemplified by a fishing spider (*Dolomedes* sp.) that is an important predator on the tadpoles of the veined treefrog, *Trachycephalus typhonius*, when they are available (Schulze and Jansen, 2010: as *T. venulosus*). In the Neotropical region, spider predation upon frogs is mainly attributed to five families: Ctenidae, Pisauridae, Lycosidae, Sparassidae and Theraphosidae (Menin et al., 2005). Below we mention a few documented cases of anurophagy (from the Greek for "feeding on frogs") by arachnids.

Owen and Johnson (1997) report that on 11 April 1992, in a cypress dome on the campus of the University of Central Florida, they encountered a gravid female *Pseudacris ocularis* (little grass frog) being held by an immature male wolf spider, *Lycosa* sp. (Lycosidae).

Jefferey et al. (2004) describe two observations of Okefenokee fishing spiders, *Dolomedes okefinokensis*, preying on green treefrogs, *Hyla cinerea*, during an inventory of amphibians and reptiles in Big Cypress National Preserve, Collier County, Florida, USA. On 15 March 2002 a *D. okefinokensis* had a *Hyla cinerea* in its chelicerae above 70-cm-deep water on the trunk of a *Taxodium distichum* (bald cypress). On 4 December 2002 a second *D. okefinokensis* was observed preying upon another *H. cinerea*.

Cicchi et al. (2010) report observing an adult male *Scinax* (= *Ololygon*) *littoralis* (snouted treefrog) being consumed by the spider *Ctenus medius* on 21 September 2008 in Ubatuba, São Paulo, southeastern Brazil.

Costa et al. (2010) document predation of an adult male *Physalaemus spiniger* (Iguape dwarf frog) by a juvenile theraphosid spider. This happened on 28 October 2008 at Reserva Natural Salto Morato, Guaraqueçaba, Paraná, southern Brazil.

Costa-Pereira et al. (2010) report that their cameras recorded two predation events by spiders on the young of the treefrog *Osteocephalus taurinus*. The spiders were *Neoctenus* sp. and an unidentified pisaurid species. The observations occurred during a study of the effects of filling the Pequena Central Hidrelétrica Bocaiúva Dam in Brasnorte municipality, Mato Grosso, Brazil, in November 2009.

De-Carvalho et al. (2010) reported on two predation events

on adults of *Ischnocnema* (= *Pristimantis*) *ramagii* (Paraiba robber frog) by the spiders *Ancylometes rufus* and *Ctenus rectifier* (Ctenidae). These events happened on 2 October 2008 and 20 November 2008 in an area of Atlantic forest in the Parque Nacional Serra of Itabaiana, Sergipe, Brazil.

De Freitas and Santos Silva (2010) report observing predation of *Phyllodytes luteolus* (yellow heart-tongued frog) by the spider *Phoneutria* cf. *bahiensis*. This occurred on 13 April 2006 on a terrestrial bromeliad in the coastal ecosystem at Belmonte Municipality, Bahia, Brazil.

Farr et al. (2010) describe finding an unidentified tarantula (Theraphosidae) preying on a *Spea multiplicata* (Mexican spadefoot) on 14 October 2006 in the municipality of Miquihuana, state of Tamaulipas, Mexico.

Gibbons et al. (2010) report on observing a juvenile *Cupiennius getazi* (spot-legged banana spider) eating the eggs of a red-eyed treefrog, *Agalychnis callidryas*, on 28 June 2008 in the Researcher's Swamp at La Selva Biological Station near Puerto Viejo de Sarapiqui, Costa Rica.

Hamidy et al. (2010) report a *Heteropoda* sp. (huntsman spider) preying on a *Rana* (= *Pulchrana*) *picturata* (yellow-spotted frog) at Takah Selow Waterfall, Selai, in the Endau-Rompin National Park, Johor, peninsular Malaysia, on 2 August 2008.

Hertz and Lotzkat (2010) describe detecting a large amblypygid (whip scorpion) on 31 March 2009 holding an almost digested female *Cochranella* (= *Sachatamia*) *albomaculata* between its chelicerae at Cerro Negro, Veraguas Province, Panama.

Almeida-Reinoso and Coloma (2012) document finding a female *Clubiona* sp. (leaf-curling sac spider) preying on *Rulyrana* (= *Sachatamia*) *orejuela* (Orejuela glass frog) on 31 October 2009 in the Aguas Verdes stream. The area is at the southern border of Reserva Ecológica Cotacachi Cayapas, Provincia de Imbabura, northwestern Ecuador.

Gaiarsa et al. (2012) describe two predation events. On 13 June 2008, during a monthly monitoring of a frog population at Núcleo Picinguaba of the Parque Estadual da Serra do Mar, São Paulo state, Brazil, they found an adult spider, *Trechaleoides biocellata*, preying upon a juvenile *Cycloramphus boraceiensis* (Boraceia button frog) in a stream. In another event on 4 July 2008, at the same site the same authors observed an adult *C. boraceiensis* now preying upon an individual of the same spider *T. biocellata*, species.

Sugai et al. (2012) describe an adult *Physalaemus albonotatus* (Menwig frog) being preyed upon by a spider of the family Lycosidae on 17 March 2011 in a Cerrado area in central-western Brazil. The event was observed at the margins of a swamp surrounded by exotic grass (*Urochloa* sp.) in the county of Vincentina, state of Mato Grosso do Sul. This was the first record of spider predation on *P. albonotatus*.

Bovo (2013) reports the banana spider *Phoneutria nigriventer* preying upon an adult *Scinax fuscovarius* (snouted treefrog) on 30 May 2010 on a road in a riparian forest near the Mogi-Mirim River, municipality of Conchal, state of São Paulo, southeast Brazil.

Silva-Silva et al. (2013) report predation of an adult male *Rhinella granulosa* (granulated toad) by a banana spider of the genus *Phoneutria* (Ctenidae). This observation occurred on 10 July 2013 at a residence in an urban area in the municipality of Santana, state of Amapá, in northern Brazil. The event lasted at least eight minutes and during this time the spider had already captured the anuran with the aid of its pedipalps, and its chelicerae were inserted in the prey's lateral body.

Folly et al. (2014) describe witnessing a young male wolf spider, *Hogna* sp., capturing a *Dendropsophus pseudomeridianus* tadpole on the surface of the water of a permanent pond. This took place on 17 February 2014 in the municipality of Guapimirim, state of Rio de Janeiro, Brazil.

Jiménez-Arcos et al. (2014) report finding an adult male *Bonnetina papalutlensis* (Mexican blue-footed tarantula) with a newly metamorphosed *Agalychnis dacnicolor* (Mexican leaf frog) in its chelicerae. This took place on 16 November 2011, in the municipality of Acaxtlahuacan de Albino Zertuche, in the state of Puebla, Mexico, in the remnants of a temporary pool formed during the wet season.

Ramírez-Castaño et al. (2014) describe seeing a theraphosid spider, *Xenesthis immanis*, carrying an individual of *Hyloscirtus palmeri* (Palmer's treefrog) in its chelicerae and moving between rocks along a creek. This happened on 19 January 2009 during a field survey in El Palmar Creek, La Sonrisa village, municipality of Samaná, department of Caldas, Colombia.

Champagne et al. (2015) report observing a fishing spider, *Ancylometes* sp., feeding on an adult *Engystomops petersi* (Peter's dwarf frog) on 12 June 2012 near a small, closed canopy stream in the vicinity of the San Antonio Guard Station, Heath River, Madre de Dios, Peru.

Da Silva et al. (2015) record predation on *Pseudopaludicola pocoto* by the fishing spider *Ancylometes rufus*. This observation took place on 22 January 2015 at the Ecological Station Aiuaba, municipality of Aiuaba, state of Ceará, Brazil, during the course of an active search for frogs in the vicinity of a lake.

Konvalina and Trauth (2015) describe an observation on 17 August 2015 of a *Dolomedes triton* (six-spotted fishing spider) grasping a juvenile *Hyla cinerea* (green treefrog) and trying to subdue it. The spider was perched on a reed in a water-filled ditch alongside County Road 414 in Craighead, Arkansas. *Dolomedes triton* had already been known to feed on adult *Acris gryllus* and larval *Lithobates catesbeianus*.

Priyadarshana and Perera (2015) report on an observation in Sri Lanka of *Adenomus kelaartii* (Kelaart's dwarf toad) being preyed upon by a huntsman spider, *Heteropoda* sp. The observation was made on 14 March 2015 during dry weather, on a rock outcrop of a fast flowing stream bank in Hunuwela Rubber Estate, Ratnapura District, Sri Lanka.

Villanova et al. (2015) record two predation events on *Hypsiboas pulchellus* (= *Boana pulchella*) (Montevideo treefrog) juveniles by wolf spiders (Lycosidae). Both observations were made on 9 November 2013 in flooded grasslands of Punta Lara Nature Reserve, Buenos Aires, Argentina. In the first case, the predator was an adult male *Lycosa erythrognatha*. The second predator

corresponded to a species belonging to an undescribed genus of the Lycosidae. These events happened during the conclusion of the *H. pulchellus* larval cycle when juveniles are very abundant.

Arteaga-Tinoco et al. (2016) report having observed an adult female *Latrodectus mactans* (southern black widow) feeding on an adult *Hyla eximia* (mountain treefrog) on 9 May 2016 during field work at the municipality of Ichaqueo, Michoacán, Mexico.

Ríos-Rodas et al. (2016) describe finding an adult *Dendropsophus microcephalus* being preyed upon by a *Cupiennius salei* (tiger wandering spider). This event occurred on 22 April 2016 in Villahermosa, Tabasco, Mexico, during night sampling in a patch of secondary vegetation within the División Académica de Ciencias Biológicas, Universidad Autónoma Juárez.

Wizen and González de Rueda (2016) report having observed on 15 February 2016 an adult amblypygid (tailless whip scorpion), *Heterophrynus armiger*, preying on a *Pristimantis achatinus* (Cachabi robber frog). The encounter took place in forest reserve "El Jardin de los Sueños" in the municipality of La Maná in Cotopaxi Province, Ecuador.

Assis et al. (2017) report that on 24 May 2016 they found an *Ancyloetes concolor* (fishing spider) feeding on an adult male *Barycholos ternetzi* (Chimbo frog) in the municipality of João Pinheiro, Minas Gerais, Brazil.

Deluna and Montoya (2017) note that on 9 July 2016, early in the afternoon, they found a nursery web spider, *Dolomedes holti*, consuming a *Rheohyla miotympanum* (small-eared treefrog) at the edge of a small creek in the municipality of Santiago in the Mexican state of Nuevo León.

De Mira-Mendes et al. (2017) report that on 7 June 2015 they observed an adult female spider, *Ctenus rectipes*, preying upon an adult *Physalaemus camacan* on the surface of a temporary pond in a fragment of the Atlantic forest of the Reserva Ecológica Michelin, located in the municipality of Igrapíuna, Bahia, Brazil. The predation event was in advanced stage; the spider had already ingested the frog's anterior region.

Gallego-Carmona et al. (2017) report on a ctenid spider preying upon an adult *Engystomops pustulosus* (Túngara frog) on 31 March 2013 in the Reserva Natural Tití Cabeciblanco of ProAves Foundation, Mutatá, Antioquia, Colombia. When first observed, the frog was still vocalizing while the spider had its chelicerae inserted into the frog's neck. During 5 min of observation, the frog did not attempt to escape. Spiders of the family Ctenidae are well-known predators of amphibians, and several events have been reported in the literature. Considering that spiders can reach high densities on the forest floor and *E. pustulosus* is abundant, the encounters between these species should be frequent, but depending on circumstances and relative sizes either species could be the predator and either might be the prey.

García-Vinalay and Pineda (2017) report that they observed an adult male *Rheohyla miotympanum* (small-eared treefrog) being captured and consumed by a *Cupiennius salei* (tiger wandering spider). This encounter occurred on 19 August 2014 in the locality known as Zona de Proteccion de Flora y Fauna Santa Gertrudis, municipality of Vega de Alatorre, Veracruz, Mexico, in a patch of secondary vegetation within tropical rainforest.

Melo-Sampaio et al. (2017) report that on 5 August 2011 they found an adult *Adenomera hylaedactyla* (Napo tropical bullfrog) being preyed upon by an *Ancylometes rufus* (Amazon wandering spider) in leaf litter. Five minutes later, another spider, *Ctenus* sp., was observed preying on a juvenile *A. hylaedactyla*. Both predation events occurred in a small forest fragment in Rio Branco, Acre, Brazil.

Nyffeler et al. (2017) document a jumping spider (family Salticidae), *Phidippus regius*, preying on treefrogs (*Hyla* sp. and *Osteopilus septentrionalis*) in Florida. Female as well as male *P. regius* were engaged in feeding on this type of vertebrate prey. A total of eight incidents of *P. regius* devouring vertebrates have been witnessed in seven Florida counties. Vertebrate predation by salticid spiders had not been previously documented in the scientific literature. The authors report that together with Salticidae, spiders from 27 of 114 families (24%) are currently known to occasionally consume vertebrates.

Vásquez-Cruz et al. (2017) report having found on 3 October 2015 a juvenile *Anotheca spinosa* (= *Triprion spinosus*) (coronated treefrog) being consumed by a *Cupiennius salei* (tiger wandering spider). This took place in a patch of tropical semideciduous forest in Colonia Agrícola Rincón de las Flores, Tezonapa, Veracruz, Mexico.

Abarca et al. (2018) document the predation of *Agalychnis annae* (blue-sided leaf frog) by a male ctenid spider *Cupiennius coccineus* (wandering spider) on 11 October 2017 in Santo Domingo de Heredia, Heredia Province, Costa Rica.

Acevedo et al. (2018) report that on 1 June 2014 they observed a ctenid spider, *Ancylometes bogotensis* (giant fishing spider), preying on an adult male *Aromobates cannatellai* (Cannatella frog) in the locality of La Garita in the department of Norte de Santander, Colombia.

Asad et al. (2018) report on the predation of a froglet of *Alcalus baluensis* (dwarf mountain frog), by a female *Heteropoda* sp. (huntsman spider) on 6 March 2018 within the Deramakot Forest Reserve, Borneo, Malaysia. This spider is a member of the family Sparassidae, known to prey upon vertebrates.

Guerra et al. (2018) report observing a fishing spider, *Ancylometes concolor*, on 5 January 2017 feeding on a male *Physalaemus cuvieri* (barker frog) on the banks of a temporary pond in an urban park at Goiânia municipality, in the state of Goiás, Brazil.

Pinto-Silva and Neuhaus (2018) describe observing the capture and predation of an adult *Scinax alter* by the pisaurid spider *Thaumasia velox* on 15 July 2016, in a lake at Reserva Ecológica de Guapiaçu, Cachoeira de Macacu, Rio de Janeiro, southeastern Brazil.

Sanches et al. (2018) report an observation on 7 September 2017 of a ctenid spider, *Ctenus ornatus*, trying to prey on an adult *Scinax ruber* (red-snouted treefrog) at the edge of a small temporary pond surrounded by a secondary forest fragment at Campus Marco Zero do Equador, Universidade Federal do

Amapá, municipality of Macapá, Amapá state, Brazil. Even though the frog got loose, it later died.

An article elsewhere in this *Bulletin* (Babangenge et al., 2019) provides a discussion of frog-eating spiders in the Afrotropics.

Commensalism / mutualism between arachnids and amphibians

Commensalism is a relationship between two kinds of organisms in which one obtains food or other benefits from the other without damaging or benefiting it. Mutualism describes an association between different kinds of organisms that is beneficial to both. Here we document a few examples of these relationships between arachnids and amphibians.

A commensal relationship between *Chiasmocleis ventrimaculata* and the theraphosid spider *Xenesthis immanis* was reported by Cocroft and Hambler (1989) based on a study conducted in Tambopata Reserved Zone, Peru. Their observations indicate that both species simultaneously utilize the same diurnal retreats and forage in overlapping areas. Feeding trials suggest that *X. immanis* readily feeds on other species of anurans, and the authors' observations implicate the role of chemical defenses in preventing *X. immanis* predation on *C. ventrimaculata*.

Siliwal and Ravichandran (2008) describe their observations of a microhylid frog, *Kaloula taprobanica* (= *Uperodon taprobanicus*), and a mygalomorph spider, *Poecilotheria hanumavilasumica* sharing a hole in a tamarind tree. These observations were made during surveys in a private plantation on Rameshwaram Island (between India and Sri Lanka). *Poecilotheria hanumavilasumica* spiders are solitary and aggressive by nature. They have been observed to attack any organism coming close to them, including other individuals of the same species. Both the frog and the spider species are insectivores, though there have been records of mygalomorph spiders feeding on small snakes, lizards and frogs. The authors speculate that this could be a commensal relationship.

Ramanella (= *Uperodon*) *nagaoi* is an endemic and vulnerable microhylid frog species, distributed in lowland wet zone rainforests on the island of Sri Lanka. The species reproduces and lives in and around tree hollows. Karunarathna and Amarasinghe (2009) describe their observations, over seven years of field work, of a mutualistic association between *R. nagaoi* and two species of tarantulas, *Poecilotheria ornata* and *P.* cf. *subfusca*.

Such commensalism is also known between ecologically similar terrestrial frogs and burrowing spiders in North America. (Savitzky et al., 2012). The North American *Gastrophryne olivacea* (western narrow-mouthed toad) is aversive to a range of potential vertebrate predators, including snapping turtles (*Chelydra serpentina*) and fledgling black-crowned night herons (*Nycticorax nycticorax*) (Garton and Mushinsky, 1979). That species and several Neotropical and Asian microhylids are known to live in close association with theraphosid spiders, sharing the spiders' burrows or tree holes and not subject to consumption by the spiders (Hunt, 1980). Whether such behavior is mediated by chemical communication (allomones) and whether any such compounds have a dietary origin are unknown.

Tomasinelli and Biggi (2013), in an online article, report that the microhylid frog, *Chiasmocleis ventrimaculata* can be found within the burrows of tarantulas of the genus *Pamphobeteus*, which tolerate the frogs and never attack them.

Many documented observations of commensalism between frogs and spiders hypothesize that the amphibians may protect the spider's eggs from insect predators or parasites, while the spider's presence keeps the frogs from being attacked by other spiders or predators such as small snakes.

Discussion and Conclusion

Mexico is the fifth richest country in the world in terms of amphibian biodiversity, with a total of 376 species. Sixteen families are present in Mexico including representatives of all three orders of amphibians. Salamanders of the family Plethodontidae with 117 species comprise the most diverse group followed by the family Hylidae with 96 species. In general, endemism is very high; seven of the 16 families have more than 50% of their species endemic to Mexico including three genera of frogs and four of salamanders endemic to the country (Parra-Olea et al., 2014).

Worldwide, there are about 117 families of spiders (World Spider Catalog, 2018), and about 44,540 species (Desales-Lara, 2014), distributed throughout all existing biomes except for the polar ice caps, air and water (although some species are able to survive in water bodies). Within Mexico, there are ± 64 families, ± 423 genera (Aguayo-Morales et al., 2012) and ±2,295 species (Francke, 2011), from which nine genera and 1,059 species could be endemic (Corcuera and Jiménez, 2008). According to Desales-Lara (2014) the most significant reviews on the diversity of spiders in Mexico are those of Hoffmann (1976, 2013), which list the species of spiders present in each state of Mexico, and Jiménez (1996), which provides a list of the families and genera of spiders in Mexico and the approximate number of species per state. Most of the cases of spiders preying on amphibians that are documented in this report did not occur in Mexico. From Mexico we only document such predation in four families [Ctenidae (wandering spiders), Pisauridae (nursery web spiders), Theraphosidae (tarantulas), and Theridiidae (comb-footed spiders)] of the 64 families present in the country. The question here would be what other families or species are preying on Mexican amphibians?

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Frog-eating Spiders in the Afrotropics: An Analysis of Published and New Cases

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Abstract

We analyze a selection of new and published predation cases of spiders (Araneae: Ctenidae and Pisauridae) on Afrotropical anuran amphibians (Amphibia: Anura), including (re-)identifications of the predators and preys involved. Reported cases occurred in Cameroon, Democratic Republic of the Congo, Gabon, Ghana, Ivory Coast, Kenya, Madagascar, Mozambique, South Africa, Tanzania and Uganda. Various spider species of the pisaurid genus *Nilus* have been recorded to prey on *Leptopelis* sp. (Arthroleptidae), *Schismaderma carens* and *Sclerophrys regularis* (Bufonidae), *Hyperolius fusciventris*, *H. marmoratus*, *H. nitidulus, H. phantasticus*, *H. spinigularis* and *H. sylvaticus* (Hyperoliidae), *Phrynobatrachus* sp. (Phrynobatrachidae), *Xenopus laevis* (Pipidae), *Tomopterna cryptotis* (Pyxicephalidae) and *Amnirana albolabris* (Ranidae). *Afrixalus vibekensis*, *Heterixalus tricolor*, *Hyperolius argus* (Hyperoliidae) and *Xenopus mellotropicalis* (Pipidae) have been found to be prey of unidentified pisaurid spider species. *Leptopelis brevirostris* (Arthroleptidae) is a prey for the ctenid spider *Piloctenus* cf. *haematostoma*. *Hyperolius acuticeps* is the prey of an unidentified spider. The predator-prey interactions between spiders and frogs in the Afrotropics are probably much more varied, involving numerous taxa in both groups.

Keywords

Ecology, Arachnids, Fishing spiders, Wandering spiders, arachnology, batrachophagy, Clawed frogs, Reed frogs, Tree frogs, Puddle frogs, Toads, Tropical Africa

Introduction

Predation on fish by spiders, especially by the genera *Dolomedes* Latreille, 1804 and *Nilus* Pickard-Cambridge, 1876 (Pisauridae, often named fishing spiders), is well documented and occurs worldwide, mainly in the world's warmer areas (Nyffeler and Pusey, 2014). The role of spiders as predators of amphibians is less documented, more observations being known from the Neotropics (Menin et al., 2005) than from other geographic areas, especially tropical Africa. Although the first published observations on predation by spiders on Afrotropical amphibians are more than a century old, only a limited number has been recorded so far in a few compilations (Abraham, 1923; Bristowe, 1930; McCormick and Polis, 1982; Toledo, 2005; Barej et al., 2009) and occasional reports. Only a part of them is vouchered by photographs or preserved specimens. We perform herein a non-exhaustive review of published cases of predation by spiders on Afrotropical amphibians, with a re-evaluation of the identities of the prey and predators involved based on the available evidence, and we present new observations.

Results

Chubb (1913) reported observations made by Father P. Boneberg of the Marianhill Monastery in Natal, South Africa, of individuals of "*Thalassius spenceri*" "catching and devouring tadpoles of the toad *Bufo carens*, and adults of the little frog *Rappia marmorata*." Chubb mentioned that vouchers of these spiders were deposited in the collections of the Durban Museum, and that he examined them. Without referring to Chubb's paper, Abraham (1923) also reported Father Boneberg's observations, but in more details, identifying this time the spider as "*Thalassius fimbriatus*" and specifying that these observations took place under captive conditions. He reported that these spiders were observed feeding on an adult hyperoliid frog "*Rappia marmorata*" (now *Hyperolius marmoratus* Rapp, 1842) (snout–vent length 30 mm), a young individual of the bufonid "*Bufo regularis*" (now *Sclerophrys regularis* (Reuss, 1833)) (snout–vent length about 30 mm) and on tadpoles of the bufonid "*Bufo carens*" (now *Schismaderma carens* (Smith, 1848)) and of the pipid frog *Xenopus laevis* (Daudin, 1802). He mentioned that the spider's body measured 18 mm. Abraham (1923) illus-

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trated these predation cases on amphibians with a black-and-white photograph showing a treefrog with a vertical pupil, a distinct tympanum, and the obvious general habitus of a *Leptopelis* (Arthroleptidae), which casts some doubts about his identification of "*Rappia marmorata*" (repeated in the literature, e.g., by McCormick and Polis, 1982, itself repeated by Toledo, 2005, and others). The photographed spider was on a leaf, head down, with its chelicerae inserted in the back of the frog. We re-identify here without doubt the treefrog illustrated by Abraham (1923) as a *Leptopelis* sp. (Arthroleptidae). The spider genus *Thalassius* Simon, 1885 is now treated as a junior synonym of the genus *Nilus*. *Thalassius spenceri* (Pickard-Cambridge, 1898) is a junior synonym of *Nilus curtus* Pickard-Cambridge, 1876. *Thalassius fimbriatus* is a synonym of *Nilus rubromaculatus* (Thorell, 1899), found in West and Central Africa but absent from southern Africa, and thus not a candidate species for these observations made in Natal. Based on the limited diagnostic characters visible on the photograph provided by Abraham, the spider can be identified as *Nilus* sp. Among the three *Xenopus* species found in South Africa, only *X. laevis* occurs near Durban (Minter et al., 2004). Last, due to the peculiar horseshoe-shaped skin flap on their head (Channing et al., 2012), the identification of the reported *Schismaderma* tadpoles can be trusted.

In addition, because the prey was an Afrotropical frog species, we mention here studies on predation on *Xenopus laevis* by the American pisaurid *Dolomedes triton* (Walckenaer, 1837) in laboratory conditions, reported by Bleckmann and Lotz (1987). These latter authors indicated that some of the prey items used in their experiments were "juvenile clawed frogs (*Xenopus laevis*, 2–3 cm) " but they did not specify if this length represented the total length of the frogs or their snout–vent length. The given size actually represented their snout–vent length (H. Bleckmann, pers. comm. to OSGP, Oct. 2018). *Xenopus laevis* is one of the most commonly used amphibians in laboratory studies (Evans et al., 2015).

Sierwald (1988: 245) included "tadpoles and toads" in the prey range of the spider "*Thalassius spinosissimus*" (now *Nilus curtus*) in Natal, South Africa, but she did not specify which tadpole or toad species was involved. However, in an earlier publication (Sierwald, 1983: 201) she reported that *Thalassius* spiders feed among others on tadpoles of "*Bufo* sp., *Xenopus* sp., *Phrynobatrachus* sp." "*Bufo* sp." might have been applied by Sierwald to species formerly included in *Bufo*, i.e., *Poyntophrynus* spp., *Schismaderma carens*, *Sclerophrys* spp. or *Vandijkophrynus* spp., so the exact bufonid genus involved is not established. In order to feed captive *Nilus* for her experiments, Sierwald used tadpoles found in unused swimming pools in Pietermaritzburg; unfortunately, no tadpole voucher was preserved (P. Sierwald, pers. comm. to OSGP, Jan. 2019).

In a field guide to the reptiles and amphibians of Madagascar, Glaw and Vences (1994: 22: Fig. 70) provided a black-and-white photograph of a spider with the caption "Frog-eating spider, Benavony." No more information is to be found in the book about this spider or which amphibian species it was consuming. On the basis of the characters visible on the photograph, the spider can at best be identified as a pisaurid. Benavony is located in Ambanja District in northern Madagascar.

Rödel (1998) mentioned pisaurid spiders as frequent predators of surfacing tadpoles at savanna ponds in Comoé National Park, Ivory Coast. In this park the same spiders were also often observed feeding on breeding *Hyperolius* and *Afrixalus* species (MOR, unpubl. obs.). Unfortunately, none of the spiders was collected, nor have the predation events been documented by photographs (exception see below).

McIntyre (1999) reported "*Thalassius spinosissimus* (or possibly *T. margaritatus*)" predating on tadpoles of the ranid frog "*Hylarana albolabris*" (now *Amnirana albolabris* (Hallowell, 1856)) in Kibale National Park, western Uganda. The observation was unfortunately not vouchered by photographs or a reference to preserved specimens, so the exact identity of the spider remains unknown, and it should best be regarded as a *Nilus* sp.

In a book on the amphibians of the West African savannas, one of us (Rödel, 2000: 208: Fig. 279) presented a color photograph of a pisaurid spider preying on an adult male hyperoliid frog *Hyperolius nitidulus* Peters, 1875. The spider, on a leaf, is facing the frog, and its head is positioned above the lower belly of the frog (with its chelicerae possibly inserted into it). The locality where this photograph was taken was not specified in Rödel's opus, but it actually happened in Comoé National Park, Ivory Coast, most likely in 1992 (MOR, unpublished data). Based on the photograph, we (RJ) identify here this spider more precisely, as a *Nilus* sp.

Glos (2003: 87) mentioned having observed six cases of predation by pisaurid spiders on the hyperoliid frog *Heterixalus tricolor* (Boettger, 1881) in Madagascar but he did not illustrate these cases and did not refer to voucher specimens, so the generic identity of the spiders remains unknown. He did not mention if the frogs were adult or tadpoles, but they were actually adult (J. Glos, pers. comm. to OSGP, Oct. 2018).

Vonesh (2003, 2005) studied predation by pisaurid spiders, "*Thalassius* sp." (thus currently *Nilus* sp.) on the hyperoliid reed frog *Hyperolius spinigularis* Stevens, 1971 in Tanzania. He mentioned that these spiders prey upon both metamorph and adult frogs, but unfortunately did not illustrate any predation case that would allow further identification of the spider species involved. Vonesh (2003) provided several photographs of *Hyperolius spinigularis*, allowing a confirmation of the identification of the amphibian prey.

Channing (in Minter et al., 2004: 322) noted, about the pyxicephalid frog *Tomopterna cryptotis* (Boulenger, 1907) that "fishing spiders and terrapins prey upon the tadpoles." No more precise information was provided in the frog species account on the spider species involved, but the introduction to the genus mentions that they belong to the genus "*Thalassius*," thus now *Nilus*. Within the same opus, P. J. Bishop (loc. cit.: 136) mentioned, based on his personal observations, that the predators of *Hyperolius acuticeps* Ahl, 1931 include, among others, spiders, without more precision. About *Hyperolius pusillus* (Cope, 1862), G. J. Alexander (in Minter et al., 2004: 147) noticed, based on unpublished observations made by two other frog specialists (A. Turner and L. R. Minter): "The call sites favoured by this species make it particularly vulnerable to predation by

Figure 1. A pisaurid spider eating a tadpole of *Xenopus mellotropicalis* in Cap Esterias, Estuaire Province, northwestern Gabon. Photograph by B. Gratwicke.

pisaurid spiders," implying that adult frogs are involved. In tree holes in Ivory Coast where *Phrynobatrachus guineensis* Guibé & Lamotte, 1962 (Phrynobatrachidae) breed, Rödel et al. (2004: 39) found spiders "large enough to be potential predators of both metamorphosing and adult frogs."

Barej et al. (2009) reported a case of predation by a wandering spider (Ctenidae) on an arthroleptid tree frog *Leptopelis brevirostris* (Werner, 1898) in southern Cameroon; the frog's snout–urostyle length was 33.6 mm. The spider was photographed along with the frog but unfortunately the spider escaped during the observation and could not be identified with more precision. Based on the photograph, we identify it here as a *Piloctenus* cf. *haematostoma* Jocqué & Henrard in Henrard and Jocqué (2017) (Ctenidae).

In December 2009, Brian Gratwicke photographed a pisaurid spider eating a tadpole of *Xenopus mellotropicalis* Evans, Carter, Greenbaum, Gvoždík, Kelley, McLaughlin, Pauwels, Portik, Stanley, Tinsley, Tobias & Blackburn, 2015, in Sahoué (0°36'47.6"N, 9°19'14.3"E) in Cap Esterias, Komo-Mondah Department, Estuaire Province, northwestern Gabon (Figure 1). The spider was not collected but voucher *Xenopus* material (USNM 578211-578212) from the same site was deposited in the National Museum of Natural History in Washington. The photograph does not allow to decide if the spider is a *Dolomedes* or a *Nilus*, the latter being much more probable being more common in Africa.

Channing et al. (2012: Fig. 62) provided a photograph of a "Fishing spider eating *Hyperolius nasutus* metamorph." In fact, it is not a metamorph of *Hyperolius nasutus* Günther, 1865, but rather a tadpole of *Xenopus* (our re-identification of the prey was confirmed by Alan Channing, pers. comm. to MB, Nov. 2018). The locality where this photograph was taken is unknown (A. Channing, pers. comm. to MB, Nov. 2018). Based on the photograph, the spider can be identified as a *Nilus* sp.

Portik et al. (2018: 401: Fig. 9A) provided a photograph of a "*Nilus* cf. *curtus*" preying on an adult female *Hyperolius fusciventris* Peters, 1876 near Mount Kupe in Cameroon. We (RJ)

Figure 2. *Nilus* spider preying upon an adult *Hyperolius marmoratus* in Gorongosa National Park, Mozambique. Photograph by M.-O. Rödel.

agree with the identification of the spider, which had been originally made by the spider specialist Sarah C. Crews. It will be possible to further verify the identification of the predator and of the prey, as they were both preserved in the collections of the California Academy of Sciences.

In May 2013 MOR photographed a *Nilus* sp. spider predating an adult reed frog *Hyperolius marmoratus* in Gorongosa National Park, Mozambique. The spider, head down on a reed, was holding the frog with its chelicerae inserted in the posterior part of the body of the frog, itself head down (Figure 2). Bishop (in Minter et al., 2004: 139) listed spiders, without further details, among the predators of *Hyperolius marmoratus*, referring to personal observations and to Channing (2001: 165, who mentioned "fishing spiders" as predators for this frog species).

MOR and Raffael Ernst (unpublished data) observed several times pisaurid spiders preying on adult individuals of the hyperoliid frog *Afrixalus vibekensis* Schiøtz, 1967 in Taï National Park in Ivory Coast. These observations, unfortunately not photographed, took place when the *Afrixalus* were gathering during the breeding period, and represent the first known case of predation by spiders on this frog species.

Benaglia (2017) provided photographs of a "*Dolomedes*" fishing spider predating an "Argus reed frog" on Diani Beach, Kwale County, in coastal Kenya (see Figure 3). We confirm the identification of the frog as an adult female *Hyperolius argus* Peters, 1854. The structure of the eyes allow to distinguish the genus *Nilus* from the genus *Dolomedes*, which both occur in Africa, although the latter is much rarer (in *Nilus* the anterior eye row is almost as wide as the posterior one; in *Dolomedes* the anterior eye row is much narrower). The spider observed by Benaglia probably belongs to the genus *Nilus*, but without

Figure 3. Pisaurid spider (probably *Nilus* sp.) eating an adult female *Hyperolius argus* on Diani Beach in Kenya. Photograph by A. Benaglia.

absolute certainty, since its eyes are not clearly visible on the photographs he took. The genus *Dolomedes* is not known from Kenya. Bishop (in Minter et al., 2004: 139) had mentioned spiders, without more precision, among the predators of *Hyperolius argus*.

On 23 July 2017 MB photographed a pisaurid spider eating a young post-metamorph *Hyperolius sylvaticus* Schiøtz, 1967 in Bobiri Forest Reserve (ca. 6°40'40.8"N, 1°19'12"W) in southern Ghana. The spider, head down, was suspended to a stem with the help of its hind legs and a silk string (Figure 4). It was biting the posterior part of the body of the dead frog, which was already damaged due to the histolysis following the envenoming. The frog and the spider were not collected. Based on the diagnostic characters available on the photographs taken by MB, the spider can be identified as a *Nilus* sp. This represents the first record of predation by a spider on *Hyperolius sylvaticus*.

On 19 May 2018 at 21:49, in the course of an inventory of the amphibian diversity in the Kokolopori Bonobo Nature Reserve in Tshuapa Province, located south of the Congo River in the Democratic Republic of the Congo, GBB observed a spider killing a reed frog (Figure 5). They were found on a leaf about 1.3 m above the ground on the bank of Sondo River near the village of Yambimbo (0°13'47.5"N, 22°51'43.3"E). The spider was above the frog, and had its chelicerae inserted in the back of the frog. The frog showed a snout–vent length of 32.9 mm, a horizontal pupil, an indistinct tympanum, no black canthal stripe, a uniformly orange-brown dorsum, partly deep black ventral sides of body and limbs, and can be identified as an adult male *Hyperolius phantasticus* (Boulenger, 1899) of the F coloration phase. This color phase was already documented for Kokolopori (Schiøtz, 2006) and is locally common, according to Schiøtz's and our observations. The frog was already dying when found. The frog's back around the spider's bite was damaged because of a histolysis following the envenoming. Based on Blandin (1979), the spider is identifiable as a *Nilus* sp. Five *Nilus* species are known to inhabit Central Africa, but the fact that the individual involved in our observation is a subadult male prevents its identification at the specific level. The frog and the spider were preserved in ethanol and deposited in the reference collections of the *Centre de Surveillance de la*

Figure 4. *Nilus* spider eating a juvenile *Hyperolius sylvaticus* in Bobiri Forest Reserve, Ghana. Photograph by M. Burger.

Biodiversité of the University of Kisangani. This represents the first record of predation by a spider on *Hyperolius phantasticus*.

Conclusion

After verifications and corrections, the *in situ* predation cases treated here involve at least one ctenid spider genus (*Piloctenus*) and at least one pisaurid spider genus (*Nilus*). Afrotropical *Nilus* species globally prey on at least 13 amphibian species of seven anuran families: one arthroleptid, two bufonid, six hyperoliid, one phrynobatrachid, one pipid, one pyxicephalid and one ranid.

Figure 5. *Nilus* spider eating an adult male *Hyperolius phantasticus* in Kokolopori Bonobo Nature Reserve, Democratic Republic of the Congo. Photograph by G. Badjedjea Babangenge.

Afrotropical ctenid spiders prey on at least one amphibian genus (Arthroleptidae: *Leptopelis*). Although not yet documented, Afrotropical caecilians (Amphibia: Gymnophiona) are also potential prey of spiders, as was already documented for caecilians in the Neotropics (see among others Boistel and Pauwels, 2002). Other spider genera and families found in tropical Africa are candidate predators of frogs. Nyffeler et al. (2017: 240) indicated that the largest jumping spiders (Salticidae) found in Africa, such as *Hyllus* spp., would possibly be able to consume small frogs. Our compilation of observations is certainly by far incomplete, nevertheless it already allows concluding that predation by spiders on frogs and tadpoles is a common event in the Afrotropics, and we can predict very varied predator-prey interactions, involving diverse taxa in both groups.

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Table 1. Predator-prey interactions between spiders and amphibians in the Afrotropics

Predator spider	Amphibian prey	References
Ctenidae		
Piloctenus cf. *haematostoma* (Cameroon)	*Leptopelis brevirostris* (Arthroleptidae); obs. *in situ*	Barej et al. (2009), this work
Pisauridae		
Dolomedes triton (USA)	Juv. *Xenopus laevis* (Pipidae); all obs. in captivity	Bleckmann and Lotz (1987)
Nilus cf. *curtus* (Cameroon)	Adult *Hyperolius fusciventris* (Hyperoliidae), obs. *in situ*	Portik et al. (2018)
Nilus sp. (Uganda)	*Amnirana albolabris* tadpoles (Ranidae), obs. *in situ*	McIntyre (1999)
Nilus sp. (South Africa)	(Sub)adult *Leptopelis* sp. (Arthroleptidae), *Schismaderma carens* tadpoles, young *Sclerophrys regularis* (Bufonidae), *Xenopus laevis* (Pipidae), all obs. in captivity	Chubb (1913), Abraham (1923), this work
Nilus sp(p). incl. *N. curtus* (South Africa)	Bufonidae, *Phrynobatrachus* sp. (Phrynobatrachidae), *Xenopus* sp. (Pipidae), obs. *in situ*	Sierwald (1983, 1988)
Nilus sp. (Ivory Coast)	Adult *Hyperolius nitidulus* (Hyperoliidae), obs. *in situ*	Rödel (2000), this work
Nilus sp. (Tanzania)	Metamorph and adult *Hyperolius spinigularis* (Hyperoliidae), obs. *in situ*	Vonesh (2003, 2005)
Nilus sp. (southern Africa)	*Tomopterna cryptotis* tadpoles (Pyxicephalidae), obs. *in situ*	Channing (in Minter et al., 2004)
Nilus sp. (Mozambique)	Adult *Hyperolius marmoratus* (Hyperoliidae), obs. *in situ*	This work
Nilus sp. (Ghana)	Metamorph *Hyperolius sylvaticus* (Hyperoliidae), obs. *in situ*	This work
Nilus sp. (Democratic Republic of the Congo)	Adult *Hyperolius phantasticus* (Hyperoliidae), obs. *in situ*	This work
Nilus sp.? (Kenya)	Adult *Hyperolius argus* (Hyperoliidae), obs. *in situ*	Benaglia (2017), this work
Nilus sp. (country?)	*Xenopus* sp. tadpole	Channing et al. (2012: Fig. 62), this work
Pisauridae gen. et spp. (Ivory Coast)	Unidentified tadpoles, adult *Afrixalus* sp., adult *Hyperolius* sp. (Hyperoliidae), obs. *in situ*	Rödel (1998), this work
Pisauridae gen. et sp. (Ivory Coast)	Adult *Afrixalus vibekensis* (Hyperoliidae), obs. *in situ*	This work
Pisauridae gen. et sp(p). (Madagascar)	Adult *Heterixalus tricolor* (Hyperoliidae), obs. *in situ*	Glos (2003), this work
Pisauridae gen, et sp. (southern Africa)	Adult *Hyperolius pusillus* (Hyperoliidae), obs. *in situ*	Alexander (in Minter et al., 2004)
Pisauridae gen. et sp. (Gabon)	*Xenopus mellotropicalis* tadpole (Pipidae), obs. *in situ*	This work
Araneae		
Araneae gen. et sp. (southern Africa)	*Hyperolius acuticeps* (Hyperoliidae), obs. *in situ*	Bishop (in Minter et al., 2004)
Araneae gen. et sp. (southern Africa)	*Hyperolius argus* (Hyperoliidae); obs. *in situ*	Bishop (in Minter et al., 2004)

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The Little Frog That Could — The Diaspora of the Rio Grande Chirping Frog, *Eleutherodactylus cystignathoides* (Anura: Eleutherodactylidae) in the United States

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Among the worst environmental news of the latter decades of the 20th century was the revelation that some populations of frogs and toads in various parts of the world had suffered drastic crashes or had become extinct altogether. Due in part to the typical amphibian lifestyle that requires an aquatic stage, many frogs have fallen victim to the rapid pace at which wetlands are being "reclaimed" and/or contaminated. Others, even though occurring in relatively pristine habitats, have been devastated by a host of fungal, viral, and other pathogens only recently identified. Worldwide, it is estimated that 168 amphibian species have become extinct during the past two decades and fully one-third of all known species are considered to be threatened with extinction (Dodd, 2013).

Figure 1. An adult Rio Grande Chirping Frog (*Eleutherodactylus cystignathoides*) from Atascosa County, Texas. Photograph by the author.

Against this gloomy observation, however, is a glimmer of encouragement. Bucking the trend, with no small but unintentional assistance from mankind, is a tiny tropical frog that once just barely entered the state of Texas in the Lower Rio Grande Valley.

Not nearly as long as its scientific name in print (*Eleutherodactylus cystignathoides*), the Rio Grande Chirping Frog has been leapfrogging (or, more accurately, hitchhiking) its way into a much wider distribution within three Gulf States during the last five decades.

I recall my astonishment at finding a single individual at an impromptu dump site in San Antonio, Texas, in 1969, 200 miles north of its known range at the time. However, within the next 40 years they were reported from Corpus Christi, Houston, and even as far north as the Dallas-Fort Worth Metroplex and Shreveport, Louisiana. These latter two localities are the northernmost reported thus far and suggest that the frogs, though tropical in origin, can probably survive decidedly "untropical" winters.

Chirping frogs belong to a primarily Neotropical group (family Eleutherodactylidae) that is extremely abundant, in both species and individuals, in more tropical latitudes. Several members of this family have been introduced, mainly via the nursery trade from several Caribbean islands, into southern Florida, where they thrive. At the generic level, the exact placement of the chirping frogs remains somewhat unresolved; they tend to bounce back and forth between the genera *Eleutherodactylus* and *Syrrhophus*, according to the most recent whims of taxonomists and phylogeneticists (one should be aware, however, that much of the limited literature on the group is found under the latter name). All three species of eleutherodactylid frogs that occur naturally in the United States are found in Texas.

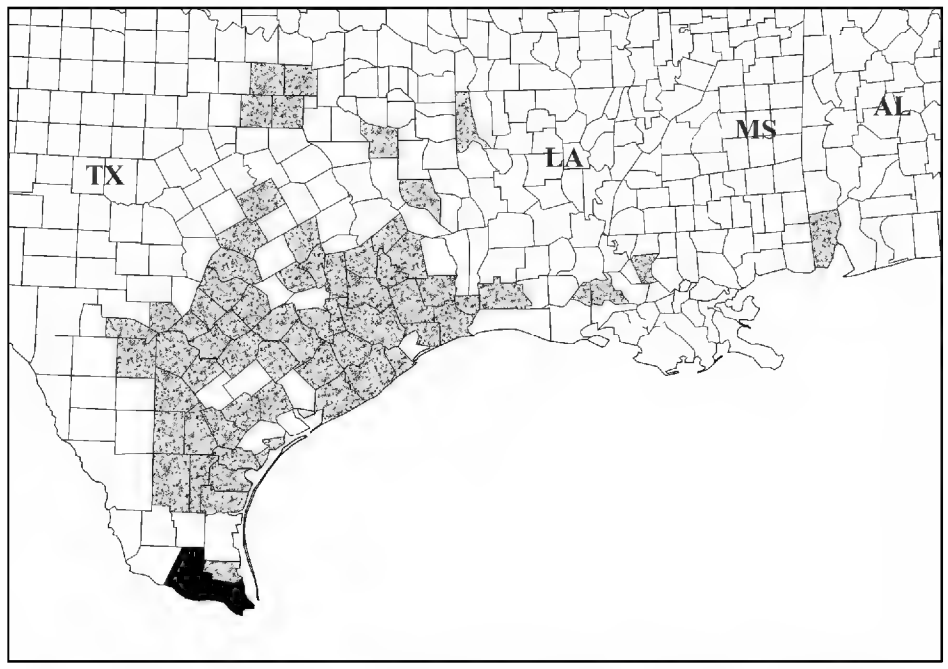

Figure 2. Map of the current distribution of the Rio Grande Chirping Frog (*Eleutherodactylus cystignathoides*) based on available records. The stippled areas represent county records since 1976. The two counties in black at the southern tip of Texas (Cameron and Hidalgo) represent the presumed original (natural) range of the species in the U.S.

The Rio Grande Chirping Frog was originally introduced to science by Leonhard Stejneger of the Smithsonian Institution. Stejneger (1915) described it as a new species, *Syrrhophus campi*, based on specimens from Brownsville, Texas. It remained thus classified until John D. Lynch's (1970) review of the genus placed it as a northern subspecies of a frog, *Syrrhophus cystignathoides*, that had been described earlier (as *Phyllobates cystignathoides*) by Edward D. Cope (1877), using specimens from southeastern Mexico. This tiny, nondescript frog remains almost as poorly known today as it was then. Except for range extensions, little has been written about it in the herpetological literature since its discovery. Even with range extensions it has become apparent that the accepted method of establishing the distributions of reptiles and amphibians (involving depositing physical voucher specimens in recognized museum collections, awaiting expert taxonomic verification, etc.) is inadequate when dealing with species experiencing rapid, even explosive range expansions.

For example, the first "official" record for *Eleutherodactylus cystignathoides* from Brazoria County, Texas (which is adjacent to the dense, long known Houston population) appeared only in 2005 (McCoid, 2005). Evidence indicates, however, that the Rio Grande Chirping Frog was present in Brazoria County almost 30 years earlier. A specimen from the town of Brazoria, collected by one of William K. Davis's field biology classes from Southwest Texas State University in 1976, resided in a study collection at the university (pers. obs.). When asked about the specimen, Davis replied that it was genuinely from that locality and that he had intended to publish a note about it, but had never gotten around to it (Wm. K. Davis, pers. comm.). This was three years prior even to the "official" announcement of the Houston population (Quinn, 1979).

Similarly, the first record indicating that *E. cystignathoides* could have established a population outside the Lower Rio Grande Valley, in San Antonio, Bexar County, was published in 1976 (Mather and Dixon, 1976). However, almost seven years prior to that, on 7 November 1969, I collected a single adult specimen of *Eleutherodactylus cystignathoides* just a few meters inside the southern limits of that city, indicating that the taxon had likely been present in Bexar County for some time before its announcement to science. The failure of both Davis and me to make timely notice of our respective discoveries is symptomatic of a "time lag" that is practically built into the traditional procedure for documenting range extensions and one which is counterproductive to our ability to accurately determine the up-to-date distribution of dynamically expanding species such as the Rio Grande Chirping Frog.

Consequently, the range map included here (Figure 2) is based upon all "reliable" available records, such as VertNet, literature records, reviewed citizen science sites (e.g., iNat, HERP database, etc.), as well as personal observations of trusted observers. It is believed that this method, similar to that employed by the birding community, yields a slightly more current and ephemerally accurate impression of the species' distribution. It should be understood, however, that by the time this reaches publication it will be rendered somewhat obsolescent by new discoveries.

For most people, their first encounter with this frog will be hearing its characteristic "chirp" in their yard; a sound more bird- or insect-like than one would probably expect. The call consists of two or three distinct, evenly spaced chirps that are cricket-like in pitch, lacking some of the insect's trill, but with much more volume. Chirping may be heard on almost any night during the warmer months, especially when the humidity is high, either naturally or from landscape irrigation.

The calls also have a ventriloquial effect, making the frog's location difficult to detect from its sound alone. Experienced frog biologists often resort to a method called "triangulation" to locate calling individuals. This consists of simply having each of two listeners simultaneously point toward the area from which each thinks the call is coming. Where the imaginary lines extending from their fingers cross, there is a reasonable expectation of finding the frog.

In keeping with generalizations about frogs, it appears that male chirping frogs alone are responsible for the calls and that they serve both a territorial and a sexual attractant function. The male probably stakes out a site favorable for egg deposition, then commences to call, drawing females to the location. However, considering the numbers of frogs occasionally found together under a single piece of debris, it is doubtful that they are strongly territorial.

One of the traits of the Rio Grande Chirping Frog that allows it to be introduced into new areas is its unusual (for a frog) reproductive cycle. It is much less dependent upon the availability of water than most other frogs for the completion of its life cycle. In fact, it bypasses the free-swimming tadpole stage altogether. The embryo develops completely within the egg, emerging as a minuscule replica of the adult.

This behavior has apparently allowed eggs laid in potted nursery stock in Texas' Rio Grande Valley to be transported in all directions as the plants are shipped out. What is surprising is that this little frog has not been reported from even more localities where it now almost certainly occurs. A similar process has allowed the Mediterranean Gecko (*Hemidactylus turcicus*, a small, wall-climbing lizard native to the Middle East) to invade

and colonize much of the southern tier of states in the U.S., mostly around human habitations. Gecko eggs, however, are far more resistant to desiccation than those of even terrestrial frogs, so I do not expect the chirping frog to ever attain a comparably extensive range to the west (although there are persistent rumors of an established population existing within a well-watered yard in Phoenix, Arizona!).

Ironically, despite its ubiquity where it occurs, we know much more about many rarer frogs, found in exotic, inaccessible localities. Being human, most herpetologists are drawn to investigate the more "glamorous" species first, ignoring this dowdy little "frog next door." Consequently, much of its interesting natural history remains equivocal.

Our most detailed and non-anecdotal knowledge of the reproductive and developmental biology of this little frog has resulted mainly from the efforts of Louise Hayes-Odum, who studied the introduced population on the grounds of the Houston Zoo in 1984. One of the initial problems she encountered was how to determine the sex of individual specimens, which superficially appear identical. Hayes-Odum solved this problem by relying upon the presence of developing eggs in adult females, which are visible through the abdominal wall, as well as their slightly larger size (>22 mm, snout–vent); nocturnally vocalizing frogs were presumed to be males. She found frogs calling from perches as high as 22 cm (8.7 in) above the ground during the night and at air temperatures as low as 20.5°C (68.9°F), but observed that they retreated towards lower perches near dawn. Most calling heard after sunrise was from frogs located within tunnels in the ground. A clutch of five eggs dug up (close to the surface) at the study site averaged ca. 5 mm in diameter and were unpigmented, even though at advanced stages of development. Wild hatchlings (ca. 6 mm, snout–vent) were first observed on 6 June.

Since, despite her efforts, Hayes-Odum failed to observe reproductive behavior in the field, she stimulated it among a captive group by the injection of a small amount of synthetic gonadotrophin-releasing hormone into both sexes. Interactions between the frogs appeared to be territorial, and on one occasion a female seemed to be soliciting amplexus from a presumed male. Incubation took from 14 to 16 days at temperatures from 27–33°C (80.6–91.4°F). Three clutches of eggs were observed, numbering 5, 10, and 13 (Hayes-Odum, 1990).

Cool winter temperatures should limit this frog's range expansion to the north. Although the San Antonio population apparently survived two unusually cold winters during the 1980s (one consisting of subfreezing temperatures for a week, the other of 13 inches of snowfall), I would not expect them to endure much farther north than the Fort Worth and Shreveport records indicate. They are, however, rapidly expanding their domain eastward along the Gulf Coast, aided no doubt by the more subtropical climate to be found there. The Rio Grande chirper is currently known from five parishes in Louisiana and their easternmost extent, as of this writing, is Mobile County, Alabama.

Interestingly, in Alabama and in at least three of the Louisiana localities where they have been found, the Rio Grande chirper is occurring sympatrically with a very similar, congeneric, exotic species, the Greenhouse Frog (*Eleutherodactylus planirostris*), which has itself been moving northward and westward from its apparent introduction point of Key West, Florida in 1863 (Lazell, 1989).

Initially, it seems that most authors expected that these introduced populations of *E. cystignathoides* would remain more or less restricted to edificarian or other human-altered habitats. However, observations from southeastern Texas and from localities as far west as Victoria and Bexar counties suggest that this species may be carving out a niche for itself in the natural environment, becoming less dependent upon human disturbances for its survival in those locales. In general, I would speculate that virtually every county in Texas east of or along I-35 likely harbors one or more localized populations of *E. cystignathoides*. The virtual absence of records for this species to the west of the I-35 corridor, except for a slight penetration onto the southeastern Edwards Plateau, is puzzling but could merely represent a sampling anomaly.

The existence of the very similar and naturally-occurring Cliff Chirping Frog (*Eleutherodactylus marnockii*) along the Balcones Fault Zone and on much of the Edwards Plateau presents the possibility of interaction between it and *E. cystignathoides*. I am presently unaware of any reports of suspected hybridization or even competition between these two species where they occur sympatrically, although Wallace (2005) opined that such contacts could detrimentally introduce hybridization, competition, and novel pathogens into the native *E. marnockii* populations. He further stated that steps should be taken to prevent further introductions of *E. cystignathoides*, but did not suggest any practical means of doing this, nor of eradicating currently well-established colonies of Rio Grande chirpers.

The vocalizations of the Cliff Chirping Frog, native to the Edwards Plateau of Texas, and the locally introduced Rio Grande chirper are very similar, consisting of several distinct chirps alternating with a similar number of trills, but there does not appear to be any diagnostic pattern in the sequence of these variations. The calls of the slightly smaller Rio Grande chirper seem to be somewhat higher in pitch than the larger Cliff chirper, but this is likely a function of relative body size and ambient temperature, with some overlap between the two species. Consequently, extra care should be exercised in the evaluation of aural records from localities where both species may occur, as their vocalizations are distinguishable only to the acutely sensitive and well-trained ear.

All amphibians share the problem of water loss through the skin. The Rio Grande Chirping Frog is essentially a "terrestrial" species, meaning that it is not dependent upon standing water, as are "semi-aquatic" forms like Leopard Frogs and Bullfrogs. Terrestrial frogs that live in semi-arid habitats must compensate, either behaviorally or physiologically, to the increased drain upon the water reserve in their tissues that such an environment exacts.

Based on my field observations, extended droughts, although a feature of its "natural" habitat in the Lower Rio Grande Valley, seem to inflict considerable stress upon the introduced populations I have studied. I suspect that, like other terrestrial amphibians of the area (e.g., the Gulf Coast Toad [*Incilius nebulifer*]),

the chirping frog may sustain itself through droughts by moving deep into cracks that develop in the black clay soil of the San Antonio area. I have also discovered some evidence that the San Antonio population occasionally uses wood rat (*Neotoma micropus*) nests (some still occupied by their builders!), along with pocket gopher and mole tunnels, as well as human-generated surface debris to evade brief interludes of cold temperature.

Of the specimens that I have found in San Antonio, the amphibians they have been most commonly associated with are the similar-sized Western Narrow-mouthed Toad (*Gastrophryne olivacea*) and, to a lesser extent, the Green Toad (*Anaxyrus debilis*). The susceptibility of chirping frogs and their eggs to the voracious invasive fire ant (*Solenopsis invicta*) is unknown, although the two associated species named above seemed to have accommodated this environmental insult. I suspect that Narrow-mouthed Toads even successfully feed upon fire ants.

The predators of the Rio Grande Chirping Frog are not well known but any of a number of small snakes occupying similar habitat are likely candidates. Several authors have suggested that in the Lower Grande Valley and points to the south, the Black-striped Snake (*Coniophanes imperialis*) is a significant predator of this species (e.g., Conant, 1955). Garter snakes (*Thamnophis* spp.) are known to actively prey upon the closely related Cliff Chirping Frog (*Eleutherodactylus marnockii*) of the Edwards Plateau, so it is probable that they are major predators of the Rio Grande species also. Larger spiders are also known to prey upon small frogs: Chris Harrison photographed an undetermined species of tarantula attacking a frog of this species in Tamaulipas, Mexico, in 1999 (Harrison, 2010).

Frogs typically rely on toxic skin secretions as their first line of defense against predators but, again, little is known about the dermal pharmacology of this species. At least one hobbyist has anecdotally alleged that Rio Grande chirpers were toxic to water snakes (*Nerodia*) that consumed them as well as to other amphibians with which they merely shared enclosures. Another, however, routinely used them without problems to entice feeding in hatchling Green Tree Pythons (*Morelia viridis*).

Introduced species are typically ill-regarded by ecologists, with the implication that introductions, whether deliberate or accidental, are never beneficial for the recipient ecosystem. Considering the lack of baseline data for the Rio Grande Chirping Frog, the jury may be out for some time on this species. Given that it is largely edificarian in the areas into which it has been introduced, occupying habitats already grossly altered by human activity, I am inclined to consider this cheerful little amphibian to be, at worst, neutral. Having been documented to feed upon cockroaches, it is certainly welcome around my house!

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Night Fighting and Other Bad (Human) Behavior

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Anybody who has read these columns will no doubt know that for almost 15 years, this author was a co-PI (that is, one of two principle investigators) on a radio-telemetry study of four rattlesnake species (*Crotalus atrox*, *molossus*, *tigris* and *scutulatus*) and Gila Monsters (*Heloderma suspectum*). My partner in this study was Dr. Gordon Schuett. Without him, the study would never have been initiated. In less modest fashion, we can also say that without me, the study would not have happened either. The two of us were as thick as thieves, as the saying goes. For the most part, we got along well during our association. But our lineages are both strongly Germanic—all the way back to Adam and Eve. Yes, Adam and Eve were Germans—it says so in the part of the good book that King James dropped. Yup! The original first verse of Genesis was "In the beginning, God created the Germans, and saw that it was good." That didn't set too well with the British court of King James, so in due course they cut out that verse.

I believe that it was Winston Churchill who once scornfully declared: "The Hun is always either at your throat or at your feet!" Truer words were never spoken. Yes, like many other clades of people in the world, there are good things about Germans, and there are bad things about Germans. Whenever two or more Germans are united in a cause, there *will* be discord. Gordon and I had some of that going on. But in the end, and to this very day, once all the yelling and cussing was over, we decided that the project was bigger than both of us. We continue to operate in this vein. We still have 20 peer-review papers to knock out—Gordon already has the titles. That means at least 21 fights are about to happen, the first of which will be me telling him: "You got the data books too—*you* write the papers if you want them that badly!"

There is a lot involved with even the simplest of radio-telemetry projects. But there was nothing simple about the rapid way our study evolved into *real* work. We started with three Western Diamond-backed Rattlesnakes (*Crotalus atrox*) [hereafter called *atrox*], two Black-tailed Rattlesnakes (*Crotalus molossus*), and two Gila Monsters (*Heloderma suspectum*). If the two of us went out to track all seven animals, we were in for a *long* day or night. But that was all right with me because I *loved* seeing what these seven animals were doing. What I didn't love was stumbling across, and having to process, *every stinking atrox* we encountered. That would include not only what we found on the study plot, but on the roads there and back. There was a time when I was trying not to find them. And they showed up in droves just to spite me. There were also times when we were finding so many new *atrox* that we didn't have time to track a single one of our subjects! Each new *atrox* took an hour to process thoroughly, and another hour to get back to its proper location. Sooner or later, something had to give. It was me!

Radio-tracking at night is a cumbersome process in and of itself. Everything must be done with a headlamp, which on some nights drew in prodigious swarms of insects. Each time I looked at my GPS, my glasses had to come off so that I could see it. That would cause me to get bugs in my eyes. In the early days, when we came across a new *atrox*, we would bag it and carry it with us, to process later. On a good night, that meant we would each have backpacks full of both scientific equipment and squirming, venomous snakes. Before we could get to that equipment required for logging the animals we were tracking, we had to remember that there were venomous snakes in sacks all entangled around that compass, or GPS, clipboard, or flagging—any number of the implements that come as accessories to the science end of herpetology. It was all an accident waiting to happen. Each new *atrox* that we caught required all the same write-ups that our telemetered subjects received, along with the added burden of careful metrics, sexing, and the proper return to its *exact* capture spot. And then came the night where we had ***seven*** atrox to release, while still attempting to track the other animals. That wasn't bad enough. It began to pour down rain, and the winds kicked up to hurricane proportions. It was windy, wet, and my glasses were fogging up. I was juggling my duties as the tracker, and trying to remember which new snake went where. The animals that were being tracked showed *zero* consideration for the poor tracker. I was trying to systematically track unknown locations while gunning for the release points enroute to those unknown locations.

At one point, I had my glasses off, and I was trying to GPS my way to where one of the new snakes needed to go. (Oh, by the way! Let's not trivialize how confusing it is to have seven bagged snakes in backpacks, and figuring out which is which while working in a driving rainstorm. Oh, and *another* by the way—because all our data was on paper, we had to keep each data sheet dry while fumbling about with everything else. Oh! And yet *another* by the way, I considered all this extra work to be Schuett's folly. For ten years we collected the DNA, ~300 samples total, before *ever* doing anything with it. Ten years of Roger Repp bitching lustily and thusly: "We're *never* going to do anything with this stuff. Why bother?"). During the process of releasing the first snake, I lost track of where my glasses were. After a lengthy and thorough search, we found them --- under Schuett's right foot! They were toast. So was he! A lengthy soliloquy then began, starting with a reminder to my hapless companion that he had an entire planet to stand upon, and all that I needed was the two-inch-wide by six-inch-long patch of ground that contained my glasses. Henceforth and forever, that tiny patch of ground was off limits! The first five minutes of the ensuing all-out temper tantrum focused on *that* aspect of his misstep. I next began to totally verbally assassinate the character of Schuett himself. That took some doing, as any perceived character flaws were legion in number. When finished with him personally, all the past generations of his ancestry were roundly cussed, discussed, and re-cussed. This took a while, as I verbally traveled through his lineage while in the United States, back tracking to Germany, followed by a quick stop at Mount Ararat, picking off Noah and *his* family in the process. (They

were also *obviously* Germans). I ended that part of the ass chewing at the juncture of the Tigris and Euphrates River, which was the cradle of civilization for God's first Germans. I then moved forward with his lineage, heaping many poxes and curses on the lot of them—all the way through the next millennium.

It was during that part of the rant that strong winds tore the cheap-ass rain poncho right off my body. It was one of those worthless 99-cent specials that just pull over one's head, and cover the body to the knees. Schuett thought this was *great* fun, and began laughing at me while the useless body covering soared off into the night air. As he laughed uproariously, he was mimicking the wild gesturing of my arms (sort of like a windmill punching act) as I addressed the ground, the trees, the sky, the mountains, the valleys, and the high numbers of *atrox* we were having to process. That laugh was a ***big*** mistake, and the volcano fully erupted as a result. For a full 15 minutes, foul language and strong talk completely engulfed him in a cocoon of burning hot profanity. When it all died down, we agreed to focus on just releasing the new snakes, and forget the tracking for the night. And so, for the next four hours, I got thoroughly soaked to the skin, in addition to working half blind without my glasses. This also became a topic for further discussion that not only took us through this evening, but many others to follow.

The truly incredible part of this story happened about two weeks later. Gordon and I were driving on our way home from the plot, when something big and blurry came tumbling onto the road in front of us. I locked up my brakes, and swerved to avoid hitting it. As we passed by, we both recognized it. It was that 99-cent rain poncho! It somehow had worked its way out of a wash full of trees and vegetation, and traveled across a half mile of undulating, cactus-infested bajada. And talk about timing? It blew across the road right in front of us! There were more potential hang ups for that poncho than a telemarketer experiences in a lifetime! What are the odds? Maybe somebody was trying to teach us something about littering in paradise? Needless to say, the tattered eyesore was removed, and still resides in the bottom of my truck box. At least as long as it is there, it will remain out of some poor sea turtle's stomach!

World's Record GOMO Scat

For the first 30 years of my life, animal poop that was encountered while hiking remained right where it belonged—on the ground. It was not until after moving to Arizona that my biologist friends—turd lovers all—taught me the importance of proper turd examination. These days, no turd remains unturned when I am in the vicinity. Of all the turds that I have fondled, the anal butt buds of the Sonoran Desert Tortoise (*Gopherus morafkai*) [GOMO] are by far my favorite. GOMO nuggets were the first herp sign that I learned to identify in the wild. They are mainly composed of elegantly woven grasses, somewhat bulky, yet as light as a feather, and most are distinctly shaped like a two inch long olive-drab colored mini football. Hence, my favorite sport *and* my favorite turds are represented in a neatly packaged bundle, and they are found while I'm engaged in my favorite pastime. Tortoise scat, football, and herping! The finest things in life were just wrapped up in five words! When exploring new ground, the first thing this author does is to note the presence or absence of GOMO scat. This author considers a hefty tortoise population an indicator species of hefty populations of other herps. If prodigious amounts of tortoise scat are found, the good field herper will know that he (or she) is walking in tall cotton without even having to see an actual tortoise.

On one particular morning, (the date of which eludes me and is of zero importance), Gordon and our mutual friend Rich Ihle bombed down from Phoenix for some tracking fun. They actually arrived before me on this day. The first thing that would usually happen before we even began threading up the receiver is that we would check *atrox* den number 1 (AD1). AD1 was less than 50 meters from our parking spot. There were also several tortoise burrows in the vicinity to check. Upon our approach to one of these, I noted a *huge* tortoise scat deposited just outside the burrow. This Genghis Kahn of a turd was easily four inches long, by perhaps two inches wide. Somewhere on this plot of ours was a *massive* GOMO, and pleased I was to have the evidence of its existence in hand. I showed the prize to my two comrades, who were equally wide-eyed and impressed with its gargantuan size. With great enthusiasm, I carefully placed it in a Ziploc bag, and circled about the area seeking the cloaca from which it had egressed. No luck, but I knew that time was on my side. Somewhere on our hill was one helluva big tortoise, and sooner or later, it would pop up for us.

I was president of the Tucson Herpetological Society (THS) when the "Turdasaurus" was discovered and bagged. One of the perks of holding this extinguished position was that once a month, I would stand before an audience of about 60 members. (Actually, the number was probably more like ten members, plus 50 pikers who had not paid their dues in over a decade). While at the podium, I would make announcements, introduce speakers, and generally make a jackass of myself. It so happened that one of the monthly meetings occurred a couple days after I had snagged Turdasaurus. I stood before about 60 or so people, and held an impromptu show and tell with my prize zinger in hand. During this time period, the THS was infested with tortoise nerds, mainly because there was money to be had by studying and/or breeding them. A small gaggle of tortoise folk gathered around the podium, and the turd was unbagged and heavily scrutinized as it was passed from hand to hand. One of the tortoise nerds was a biological heavy hitter, and offered to analyze it. I agreed to let her do this, but I only wanted her to break a very small bit of it off, as I wanted to keep my trophy turd as large as possible for exhibition purposes. This she promised to do for me. The parting was painful for me, and I spent the next month in anguish jonesing for my world class trophy. The tortoise queen was as good as her word. She had the turd examined, and it was packed with the right amount of native grasses and seeds to be declared genuine. However, I felt that she crossed the line when she requested that I give her the GPS location of my prize. I knew she was trying to horn in on *my* find. She was going to try to find *my* tortoise, no doubt! I abruptly nipped her covetous inquiry in the bud, and she hasn't spoken to me since. Greed does horrible things to tortoise nerds. I found her overtly inquisitive approach quite unbecoming, and told her so. Good riddance! I perched my find of the century atop the victory cup of a baseball trophy that I had, and displayed it in a prominent place in my office at home, where

visitors from all over the world have seen it and marveled.

About ten years after all this happened, Rich Ihle and Gordon once again joined me for a tracking adventure. At the end of it all, when we were relaxing with a beer in hand, Gordo dropped the bomb on me. Rich had been keeping African Spurred Tortoises through the years, and both he and Rich thought it would be great fun to put one of their scats in front of one our often-checked GOMO burrows. Sure enough, my world's record GOMO turd was from one of Rich's pets. They thought their little prank was uproariously funny, and I nodded obsequiously while laughing along with them. "Har-DE-har, you guys are S-O-O-O-O funny! Har-har-har, so clever . . . "

I do hope that in the future, we will all mature to the point where there will be no more phony scats placed on the ground, or any more pissing in the beer.

This here is Roger Repp, signing off from Southern Arizona, where the turtles are strong, the snakes are handsome, and the lizards are all above average.

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What You Missed at the February Meeting: Dan Keyler

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The polar vortex gripped the Midwest and CHS President Rich Crowley decided that trying to coax people from their warm homes when the temperature was in the negative 20s (Fahrenheit) might be an exercise in futility even though the speaker was outstanding, so the January meeting was canceled. Fortunately, Dr. Daniel Keyler, being from Minnesota, understood the problem and graciously agreed to fly in for our February meeting. We were happy that he was able to make it because his talk was not only interesting and informative, but also provided a break from our too long and too cold winter. His talk was titled, "Snakebite Envenoming in Sri Lanka: Polyspecific Antivenom Development." Sri Lanka is a warm country and slides of tropical animals and lush foliage made for a nice winter's evening.

Dan has been fascinated with venomous snakes since he was a young boy. Today he is a professor emeritus of experimental and clinical pharmacology at the University of Minnesota. He's been involved in snake conservation and immunotoxicology research, and has co-authored a couple of books. His biography has a lot of other entries and you can read them on our website, but if I copy and paste them all here my editor would probably complain about the article length. I think I can sum up his accomplishments by saying that I suspect he is never bored. What struck me is the last sentence in the bio. "Importantly, he spends as much time out in the field as possible where he is most content." After reading that, I was certain I would like him.

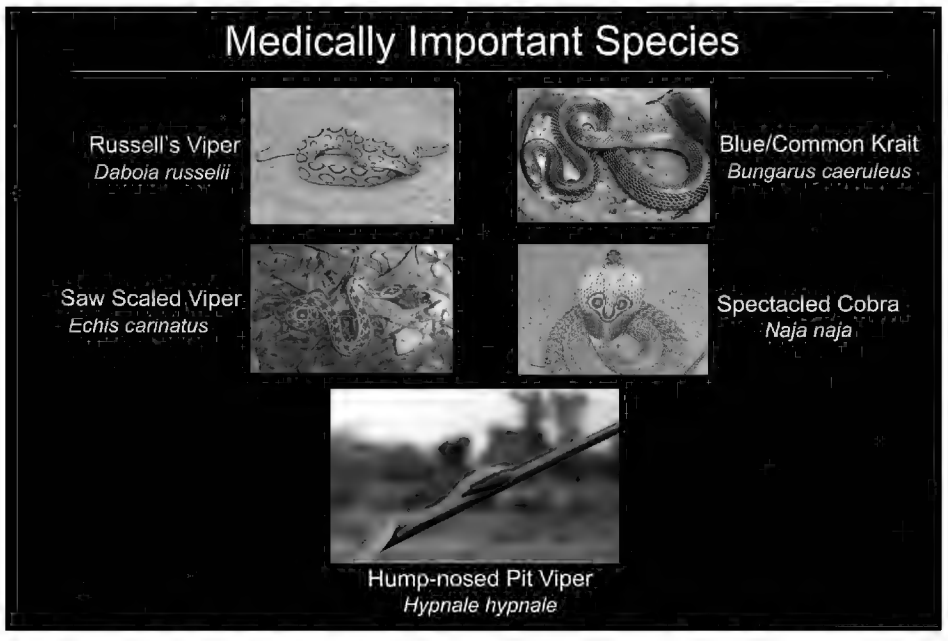
Dan was accompanied by Kim Youngberg, and he asked her to introduce the presentation. Kim mentioned how she met Dan at a conference in 2009 and talked about the snakebite problem in Sri Lanka. Kim was with Animal Venom Research International (AVRI). Sri Lanka has about 40,000 hospitalizations a year because of snakebites and two or three people a day die from bites. The only antivenoms available for Sri Lanka snakebites are from India. While the Indian antivenoms are from the same species of snakes, the venom compositions of the mainland snakes differ from those of the island's snakes. More of the antivenom is required to treat Sri Lankan victims, leading to more expense and often intense allergic reactions. AVRI wanted to develop an antivenom specific to Sri Lanka's snakes. It wasn't going to be easy.

Those of you who occasionally read these articles or come to meetings might remember Jim Harrison's and Kristen Wiley's talk about Sri Lanka [Bull. Chicago Herp. Soc. 49(6):86-88, 2014]. Indeed, they talked about the same trip. It's always interesting to get different views on the same subject, and Dan brought a unique view to the project. He started with an overview of the island. Sri Lanka is a teardrop-shaped island off the southeast coast of India, about 250 miles long by 125 miles wide. Dan showed us slides of the lush rainforest still covering much of the island, the bountiful supplies of fruits available at local markets, and animals such as toque macaques, fruit bats, and tarantulas. Dan described as "magical" seeing huge monitors (*Varanus bengalensis* and *V. salvator*) wandering in the wild. We saw photos of the daily lives of some of the locals working in fields, shoeless. Dan explained that anything covering your feet in that climate can lead to fungal infections that are more likely than snakebites. The country is primarily Buddhist, so people learn to live with the animals and environment. More slides of gorgeous snakes appeared.

Dan then took us through the process of developing an antivenom. They determined the five venomous species that were responsible for nearly all of the bites. One of the five, the hump-nosed viper, responsible for 35–45% of bites, is actually three species (*Hypnale* spp.) that had never been used in the production of an antivenom. Adverse allergic reactions to the Indian vaccines can cause severe medical problems that require additional medical procedures beyond treatment for the envenomation. The new antivenom should be a Sri Lanka specific, hypoallergenic, polyvalent antivenom.

Not a simple task. With cooperation between AVRI, the University of Peradeniya in Sri Lanka, and the Instituto Clodomiro Picado at the University of Costa Rica the challenge was attacked. Dan had praise for the Instituto Clodomiro Picado

Our February speaker, Dan Keyler, doing what he likes best. The snake is an Asian rat snake (*Ptyas mucosa*). Photograph by Kim Youngberg.



The first polyvalent antivenom developed for these five Sri Lankan snakes is now in clinical trials. These five snakes are responsible for most of the deaths from snakebite in Sri Lanka. Photographs by Kim Youngberg.

A gorgeous flying snake (*Chrysopelea ornata*). Photograph by Kim Youngberg.

One of the world's premier developers of antivenom, the institute donated their efforts in actually producing the antivenom from horses. The challenges didn't stop with the tasks required to develop an antivenom. Dan credited Kim with the difficult task of coordinating the numerous legal and political processes that led to a successful outcome. One slide was of the group meeting the first lady of Sri Lanka. Dan named the Sri Lankans, Kim, and then pointed out that he was, "sitting there in a tie kind of amazed at the whole mess."

We saw photos of the construction of the snake venom extraction facility, some of the training and extractions with the local staff, and a photo of Dan with the dog (named Avri because . . .) that adopted the facility. In keeping with local customs, a Buddhist monk conducted a blessing ceremony at the opening of the building. I was impressed with the extent that the group worked with the locals and Dan and Kim both showed their respect for the knowledge, abilities, and intelligence of the Sri Lankans.

Dan showed slides of a side trip to the village of Thambuththgama (He has trouble pronouncing it also.) The village had about 300 families of snake handlers with a long tradition of free-handling venomous snakes throughout the island. They were greeted by Raja, the king's son, holding a cobra. A night field trip allowed Raja to demonstrate his skill in capturing a Russell's viper (*Daboia russelii*) bare-handed.

Dan and Kim had nothing but praise for the dedicated staff at the new venom extraction facility. Sanat handling a cobra. Photograph by Kim Youngberg.

The start of the extraction process. Pinning a Russell's viper (*Daboia russelii*). Photograph by Dan Kyler.

Dan covered a little of the way antivenom is developed. Perhaps the most difficult task was getting the snake venom out of Sri Lanka. Both Kim and Dan spoke of the reluctance of Sri Lanka to allow the venom to be shipped to Costa Rica, but allowed that paranoia might be understandable in the light of the county's history of colonization. It took a year to get the venom shipped. Dan showed us a slide of the first vial of Sri Lankan specific antivenom. Produced in 2016, a total of 3,000 vials are now being used for clinical trials in Sri Lanka at the University of Peradeniya and the results so far demonstrate success with minimal adverse effects, low reactigenicity, efficacy, and safety.

Dan's talk contained much more than I can write. His love of field work and sense of humor were continually on display. His modesty compelled him to often mention the cooperative nature of this success. His liking for the country of Sri Lanka and its people was frequently demonstrated. We enjoyed his talk and his company. Both he and Kim are people I want to hang out with. Except it's hard to think of them without asking myself, "What have I done for the world lately?".

Raja graciously greeting the visitors to his village of snake handlers while casually holding a cobra (*Naja naja*). Photograph by Dan Keyler.

Herpetology 2019

In this column the editorial staff presents short abstracts of herpetological articles we have found of interest. This is not an attempt to summarize all of the research papers being published; it is an attempt to increase the reader's awareness of what herpetologists have been doing and publishing. The editor assumes full responsibility for any errors or misleading statements.

A NEW GENUS AND SPECIES OF SNAKE

J. A. Campbell et al. [2018, Journal of Herpetology 52(4): 458-471] describe *Cenaspis aenigma*, a new genus and species of colubroid snake from the isolated highlands of western Chiapas. The type specimen was recovered from the stomach of a *Micrurus nigrocinctus*. This enigmatic little snake possesses a unique suite of characters that defies placing it in any known genus and clearly distinguishes it from all known genera. Several of the most unusual features include subcaudals undivided throughout the length of the tail and a simple hemipenis completely adorned with calyces and having a sulcus spermaticus that remains unbifurcated until the apical portion of the organ. Neither of these characteristics is known for any other colubroid of the Western Hemisphere. Consideration of morphology places the new snake in the Dipsadidae and suggests that *Adelphicos*, *Atractus*, *Geophis*, and *Chapinophis* are among its closest relatives.

TERRAPIN REPRODUCTIVE PATTERNS

J. Donini et al. [2018, Chelonian Conservation and Biology 17(2):227-235] note that the reproductive cycles of turtles are linked to environmental factors, such as photoperiod and temperature. Currently, the reproductive physiology of diamondback terrapins (*Malaclemys terrapin*) is poorly understood, especially in Gulf of Mexico. The reproductive cycles of terrapins are thought to follow typical seasonal patterns. However, latitudinal variations in temperature regimens lead to longer-lasting warm periods, which can facilitate extended reproductive periods in some turtle species. This suggests that terrapins may show a similar change in the southern parts of their range. To elucidate aspects of the terrapin reproductive cycle, the authors sampled during the known reproductive season of a southern population of terrapins (May–July), as well as during the winter in late December and early January. They used enzyme-linked immunosorbent assays to quantify concentrations of the plasma sex hormones estradiol and testosterone, and the egg yolk protein precursor vitellogenin. Additionally, radiography and ultrasonography were used to monitor the ovarian status and egg development in females. Follicles showed no significant difference in average diameter across sampling periods with preovulatory class follicles existing in both summer and winter. Eggs were only detected from May to July, with radiographic data showing second clutches in 4 individuals. Testosterone and estradiol showed elevated concentrations throughout the nesting season, coinciding with multiple clutches of eggs, before both showed a significant decrease in winter. Vitellogenin showed peak concentrations in June with other months showing lower but detectable concentrations. The results suggest that in southwestern Florida, terrapins may have extended reproductive potential and continuous vitellogenic cycles given the presence of preovulatory follicles and high quantities of vitellogenin found in summer and winter. However, true continuous reproduction was not detected in this study.

CORTICOSTERONES FROM SHED SKINS

A. Carbajal et al. [2018, Herpetological Journal 28(3):110-116] note that the analysis of corticosterone (CORT), the main glucocorticoid in reptiles, via blood or feces provides an index of hormone concentrations over a relatively short time period. Unlike these conventional matrices, snake shed skin is supposed to incorporate circulating CORT over the period of skin growth, thus reflecting long-term retrospective levels of the hormone. This study aimed to assess the feasibility to extract CORT from shed skin of Komodo dragon and biochemically validate the quantification of the hormone by enzyme immunoassay (EIA). Additionally, possible sources of variation in shed skin CORT that could reflect biological variation were examined (sex, age, body region and season of ecdysis). Results of the biochemical validation showed that CORT can be reliably measured in shed skin of Komodo dragon by EIA through the presented methodology. Males presented statistically higher levels of CORT than females, and when accounting for males' seasonal differences, concentrations decreased significantly from spring to summer. Juveniles showed higher CORT values than adults, however, results should be interpreted with caution since the model revealed that date of ecdysis was significantly influencing CORT levels. Besides that, concentrations of CORT were not influenced by body region. Overall, the present study demonstrates a potential biological source of variation in shed skin CORT concentrations due to sex, age and season of skin ecdysis. Combined with other indicators, detection of CORT concentrations in shed skin could allow a systematic control of Komodo dragon's physiology, offering a useful tool for zoo management and providing key data for the species' conservation.

LIGHTS ON, OR LIGHTS OFF?

K. A. Mascovich et al. [2018, Chelonian Conservation and Biology 17(2):206-215] note that light pollution from beachfront hotels has the potential to impact nesting and hatching sea turtles. Education strategies could be used to alter visitor behavior and mitigate this threat. The authors tested the efficacy of a sea turtle-friendly education card that encouraged visitors to "protect the night, hide the light." Cards were placed in beachfront hotel rooms at a prominent sea turtle nesting site: Jekyll Island, Georgia. Visitor responses were assessed by conducting nightly observations to determine the proportion of occupied guest rooms with beach-visible lights under 2 different scenarios (cards present or cards absent). It was found that less than half of all hotel guests closed room blinds to minimize artificial light on the nesting beach, and compliance rates seemed to be lower during peak visitation times. The nonpersonal educational treatment (card) had little effect on visitors' sea turtle-friendly lighting choices and behaviors, highlighting the need for other approaches to encourage responsible tourist behavior at ecologically sensitive beach destinations.

DISCOVERY OF A MAJOR NEW NESTING BEACH

L. G. Fonseca et al. [2018, Chelonian Conservation and Biology 17(2):169-176] report on a newly discovered nesting population of east Pacific green turtles (*Chelonia mydas*) in northwest Costa Rica at San José Island, Murcíelago Archipelago, that rivals those of Mexico and the Galápagos Islands, Ecuador. A total of 1232 individual green turtles were tagged over 4 nesting seasons (2012–2013 to 2015–2016). Mean (± SD) annual number of nests (1077 ± 414; range, 490-1698 nests) and females (306 ± 133; range, 164-466 females) was higher than those previously reported for Pacific Costa Rica. The number of deposited nests was similar to that registered on the Galápagos main beaches, but density of nests (number of nests/km) was the second highest for any green turtle beach in the eastern Pacific. Reproductive output was similar (mean clutch frequency: 4.4 ± 2.2 clutches and mean clutch size: 75.8 ± 14.6 eggs/clutch), and mean hatching success was higher (0.89 ± 0.14) than those reported at other sites in the eastern Pacific. Because the study site was located on an island within a protected area, several of the common threats that sea turtles face at more accessible mainland sites (i.e., egg poaching, tourist development, and predation by large mammals) were absent. The data indicate that San José Island is the most important nesting site for east Pacific green turtles in Central America. The large size of this population, along with its isolated and protected status, suggest that this rookery is making a significant contribution to the conservation of east Pacific green turtles. Additional information at the country level will help determine the relative importance of Costa Rica for green turtle nesting in the broad eastern Pacific region.

NON-NATIVE TURTLE DIETS IN HAWAII

A. J. Works and D. H. Olson [2018, Journal of Herpetology 52(4):444-452] note that island ecosystems provide habitat for many endemic species that may be threatened by non-native species introductions. The authors examined non-native freshwater turtle occurrences and diets to examine potential predation effects on native species in Kawai Nui Marsh, Oahu, Hawaii. No freshwater turtles are native to the Hawaiian Archipelago. The pond slider (*Trachemys scripta*) and Chinese softshell (*Pelodiscus sinensis*) were the only turtles found in the marsh after 767 trap days. *Trachemys scripta* stomachs (n = 50) contained mostly the non-native plant *Commelina diffusa* and non-native snails (*Pomacea* sp.), whereas *Pelodiscus sinensis* stomachs (n = 5) contained mostly snails. Interspecific dietary overlap was low and intersexual dietary overlap in the sliders was high, with more diverse female diets. Small, medium, and large size classes of *T. scripta* stomachs contained different proportions of plant and animal matter, with the small size class containing less plant matter than the medium size class, and the large size class containing a greater volume of animal than plant matter. No native species were found in the stomach contents of the turtles sampled except a freshwater sponge (*Heteromyenia baileyi*). This lack of native species in their diets may have more to do with the degraded state of the marsh and lack of native taxa than with a preference for non-native taxa. A potential concern could be non-native freshwater turtle presence in pristine wetland habitats in Hawaii, because of the higher abundances of native species in those areas.

RE-EXAMINATION OF A GIANT FOSSIL TORTOISE

L. E. Brown et al. [2018, Herpetological Journal 28(2):73-86] note that the Illinois Episode was the most extensive Quaternary glaciation in North America and extended deep into the central USA, further south than any other glacial episodes. It was followed by a period of mild climate termed the Sangamon Interglacial Episode. Relatively few reptile fossil sites have been found along the lliinois-Sangamon boundary. Thus, the 1986 report of isolated fossil remains of a giant tortoise (*Hesperotestudo*) near the boundary is of particular significance. The authors re-examined this important fossil because of inconsistencies and misinterpretations of prior researchers. The three morphological characters used for prior species identification of the tortoise are faulty and unreliable. Lack of additional, pertinent, diagnostic fossil elements presently prevents positive species identification. The authors critically appraised the pollen-based analysis of climate and environment at the tortoise strata by prior researchers. Their data suggest a transitional area between forest and prairie, or savannah, but the prior researchers misinterpreted their own data, concluding the vegetation was "relatively xeric grassland." Consequently, the climate and environment at the tortoise stratum are yet to be determined. Several zoogeographical scenarios pertaining to the origin and movement of the tortoise to the collection site are presented. The most likely is perhaps northward movement from the central Gulf Coast along the Mississippi River floodplain before the major meltdown of the Illinois glaciation. East of St. Louis, the glacier met the Mississippi River floodplain and as the meltdown progressed, the tortoise could have traveled on the till plain northeast to the collection site. *Hesperotestudo* likely had considerable cold adaptation and thus may have tracked the Illinois glacier relatively closely as it melted northward.

EFFECTS OF URBANIZATION ON JARARACAS

L. H. C. Siqueira and O. A. V. Marques [2018, Journal of Herpetology 52(3):299-306] note that quantitative and qualitative alterations in the environment may have serious ecological consequences for populations of native species. Isolated forest fragments, such as those surrounded by highly urbanized areas, may function similarly to oceanic islands with differences in species diversity compared to mainland areas. These differences may include changes in prey availability and predator pressure, with consequent effects on growth and size of species that interact with those prey and predators. This study investigated body size, prey availability, and predation pressure in populations of *Bothrops jararaca* in two forest fragments within an urban environment in southeastern Brazil (a completely isolated, small forest fragment and a large, well-connected forest fragment). While the authors found no differences in mean body size or stoutness between the two populations, they did find larger specimens in the small isolated fragment. Prey availability and predator pressure also were significantly lower in the small isolated fragment. The urban environment significantly changes the population ecology between the two locations. These results suggest that lower food availability in the isolated fragment did not decrease the growth rate of *B. jararaca*, but the low predator pressure increased longevity, resulting in a higher proportion of large snakes in this population.

RECOGNIZING COOTERS BY COMPUTER

T. Suriyamongkol and I. Mali [2018, Copeia 106(4):646-652] note that mark-recapture methods used in demographic studies involve marking of animals, such as tagging, notching and tattooing. These techniques are invasive and potentially harmful to the animals. Photo-identification using natural animal markings is less invasive and has become more widely used for a range of taxa including invertebrates, fishes, reptiles, amphibians, and mammals. During 2016 and 2017, the authors studied the demographics of the Rio Grande cooter (*Pseudemys gorzugi*) using traditional mark-recapture techniques (i.e., shell notching and toe clipping). However, *P. gorzugi* displays plastral marks that could potentially be used for individual recognition. Because the photo-identification process by eye is time consuming, they tested the efficiency of three pieces of software, I3S Pattern^{+}, Wild.ID, and APHIS, for individual identification of *P. gorzugi* using plastron pattern. Matching results of each program were generated into ranks with the 1st rank being the most likely match. Within the top 20 ranked images, Wild.ID yielded the highest number of correct matches (83.87%), followed by APHIS (ITM; 69.35%), APHIS (SPM; 67.74%), and I3S Pattern^{+} (61.29%). The quality of photos significantly contributed to the software effectiveness; however, turtle age and plastron wear did not affect the accuracy of the photo-identification software. The authors concluded that Wild.ID can be used as a non-invasive photo-recognition technique for *P. gorzugi* in a short-term population study.

OVIPOSITION SITE CHOICE OF GRAY TREEFROGS

C. E. Dodd and R. Buchholz [2018, Copeia 106(3):492-500] note that the ability of organisms to respond adaptively to anthropogenic environmental change is behaviorally mediated, and recent studies indicate that anthropogenic acidification impairs behavioral responses by impacting olfactory abilities of aquatic organisms. The effect on behavior of other stressors, such as plant secondary compounds, in concert with low pH, has not been investigated. The authors sought to a) determine whether the oviposition site choices of adult female Cope's Gray Treefrogs (*Hyla chrysoscelis*) correspond with the pH and tannin conditions that maximize tadpole survival and performance in the laboratory and b) investigate the impacts of mildly acidic conditions, with and without the added stress of tannins, on the survival, development, and antipredator behavior of this frog's tadpoles. They conducted a field oviposition experiment to determine adult female site choice and reared tadpoles in acidic and tannic conditions to investigate survival and antipredator behaviors. Female oviposition site choice did not correspond with conditions that maximize offspring survival. Acidity did not reduce embryonic (pH = 4.5, 5.5) or larval (pH = 5.5) survival. Tadpole mortality was highest in tannic treatment, yet this treatment received the second most eggs in the oviposition experiment. Some aspects of tadpole antipredator behavior in mildly acidic conditions suggested impaired predator recognition, though this difference was not statistically significant. Tannic conditions appear to have the greatest negative effect on tadpole fitness, and adult females appear to respond maladaptively when offered pools with a tannin concentration likely to be created by some invasive exotic wetland plants.

FROG SURVEY COMPARISONS

T. J. Grant et al. [2018, Journal of Herpetology 52(4):371-380] note that amphibian conservation studies often rely on auditory call surveys to determine distribution, abundance, and habitat associations of anuran species. Call surveys omit important life stages, however, and conservation recommendations from call surveys alone risk creating population sinks or ecological traps. To more effectively determine the effects of a catastrophic flood on an amphibian community, the authors surveyed tadpoles and metamorphs of six anuran species in the Missouri River floodplain in 2012 and 2013. Inference gleaned from these surveys was compared to inference from previous work with call surveys. For 8 of 10 species-years, extinction probabilities were >0 for tadpole and metamorph stages, indicating there may be habitat factors affecting tadpoles and metamorphs beyond those affecting calling adult males. In several cases habitat associations for tadpoles and metamorphs were discovered that were not present during call surveys. The authors had previously recommended shallow slopes for Blanchard's cricket frog, but found slopes that were too shallow were detrimental for metamorph emergence. Woodhouse's toad metamorphs had opposite preferences for slope than adults and preferred larger wetlands with less emergent vegetation. Gray treefrog tadpoles had preferences for emergent vegetation that differed from adult requirements. This work highlights the need to consider habitat factors affecting life stages beyond calling adult males. Amphibian conservation and management should proceed with sufficient information on critical aquatic life stages.

HOW RACCOONS FIND DIAMONDBACK TERRAPIN NESTS

S. E. Edmunds et al. [2018, Journal of Herpetology 52(3):307-312] note that as is true for many North American turtles, nest predation by raccoons (*Procyon lotor*) is the primary cause of mortality of diamondback terrapin (*Malaclemys terrapin*) eggs laid at Jamaica Bay, New York, USA. Previous research using artificial nests at this site indicated that raccoons located nests based on soil disturbance and ocean water scent, were repelled by human scent, and that vinyl marking flags did not increase predation rates. To test whether more than a decade of subsequent field work at the same site resulted in a change in raccoon behavior, the authors replicated the previous 9 artificial nest experiments and added 4 new designs, for 13 total treatments. The experiments further tested the effects of seven potential cues used for locating nests: moisture, human scent, diamondback terrapin scent, ocean water scent, fresh water scent, soil disturbance, and flag markers. Results corroborate previous research that flag markers are not important cues for raccoons to locate terrapin nests. Contrary to previous research, this study found that ocean water scent no longer increases raccoon predation and human scent no longer repels raccoons. Also, in the first test of its kind, the authors found that raccoons dug at sites where they applied geosmin, a pungent organic compound produced by Actinobacteria, which is naturally released when soil is disturbed. The authors conclude that Raccoons in Jamaica Bay have not learned to use signs left by humans and continue to locate nests primarily by relying on the tactile cue of soil disturbance rather than visual markers, moisture, or olfactory cues.

EFFECTIVENESS OF NEST PROTECTION SCREENS

H. Pheasy et al. [2018, Chelonian Conservation and Biology 17(2):263-270] note that mammalian depredation of nests has been listed among the most significant threats to hatchling success in sea turtles. In 2013, at least 13% of green turtle (Chelonia mydas) and 25% of hawksbill turtle (*Eretmochelys imbricata*) nests were lost to domestic dog predation on Playa Norte, Costa Rica. In 2014 and 2015, plastic and bamboo protective screens were deployed to protect nests. Screens were deployed at different stages of the incubation period and the success of the nests analyzed. Predation rates increased as the seasons progressed with October and November being the peak depredation months, as well as the peak for hatchling emergences. Eggs remaining in nests that had been partially depredated had a significantly lower percentage of hatching success than eggs in undisturbed nests. There was no significant difference between timing of deployment and likelihood of a screen being breached. The likelihood of a screen being breached was highly dependent on the type of material used; bamboo screens were ca. 153% more effective than plastic and successfully prevented the complete predation of ca. 48% of nests. Bamboo screening is an inexpensive, environmentally inert, yet labor-intensive method for reducing nest depredation by domestic dogs. This screening method does not impact the hatching or emerging success of the nest.

REPRODUCTION IN SONORAN DESERT TORTOISES

R. C. Averill-Murray et al. [2018, Herpetological Monographs 32:34-50] studied female *Gopherus morafkai* reproduction for 10 yr to evaluate reproductive variation and environmental factors that influenced reproduction. In contrast to vitellogenesis in other *Gopherus*, substantial follicle growth occurred during the spring after emergence from hibernation. Vitellogenesis and egg production varied considerably among individuals. The smallest egg-producing female had a carapace length of 220 mm, and no female produced more than one clutch per year. Compared to small females, large females were more likely to reproduce in a given year and produced larger eggs, but body size did not affect clutch size. Good maternal body condition contributed to follicle growth in winter, larger clutches, and larger eggs in a clutch. Females that emerged from hibernation earlier were more likely to produce eggs. Early-emerging females also produced larger eggs than did females that emerged later. These reproductive traits contribute to a life history that resembles an income breeder compared to the more capital-breeding strategy of the closely related Mojave desert tortoise (*Gopherus agassizii*). These life history differences might convey different reproductive and population consequences of climate change.

Minutes of the CHS Board Meeting, February 15, 2019

Rich Crowley called the meeting to order at 7:38 P.M. Board members Dan Bavirsha and Jessica Wadleigh were absent. Minutes of the January 18 board meeting were read and accepted with changes.

Officers' Reports

Treasurer: John Archer presented the financial reports for January.

Membership secretary: Mike Dloogatch read the list of expiring memberships.

Media secretary: Kim Klisiak has given Mike Dloogatch access to the new sites. Mike has been editing them for grammar. Taking down the old sites remains a problem.

Sergeant-at-arms: Mike Scott reported zero attendance at the January 30 meeting, which was canceled due to the subzero temperatures.

Committee Reports

Shows: There was discussion of doing a show at the Renaissance Faire (Sammy Velazquez will reach out to the Minnesota society to see what they do).

ReptileFest: Eventbrite is up and running. Al's Beef will again provide the food, but they plan to become a Mexican restaurant later this year.

Junior Herpers: There were 34 at the February meeting. The March meeting will be a behind-the-scenes tour at Lincoln Park Zoo.

Grants: The committee will meet on February 16 to review the proposals and choose the recipients.

Awards: Sergeant-at-arms Mike Scott will present the annual service awards at next general meeting.

New Business

USARK has posted an action alert about a new bill being proposed in the Illinois House of Representatives. HB2554 (Illinois Animal Program Ban) would ban any animal species nonnative to the U.S. from being transported and then viewed by any audience. The penalty for a violation would be up to a year in jail and a $2,500 fine. Such a law would eliminate our outreach programs. The USARK website <https://usark.org/2019-blog/action-alert-illinois-hb2554/> provides information on how to contact your state representative and what to say.

The meeting adjourned at 9:03 P.M.

Respectfully submitted by recording secretary Gail Oomens

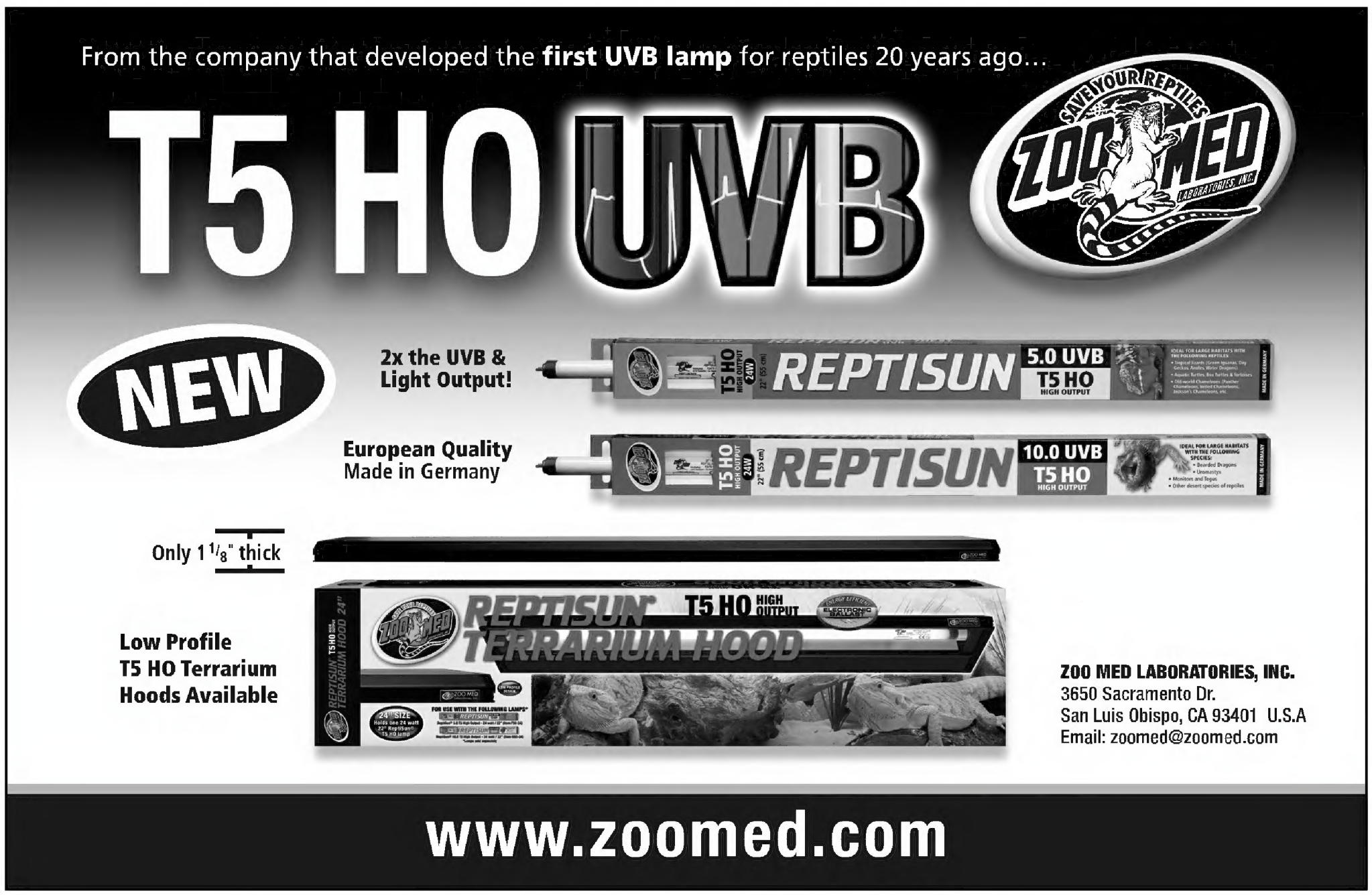
Advertisements

For sale: **highest quality frozen rodents**. I have been raising rodents for over 30 years and can supply you with the highest quality mice available in the U.S. These are always exceptionally clean and healthy with no urine odor or mixed in bedding. I feed these to my own reptile collection exclusively and so make sure they are the best available. All rodents are produced from my personal breeding colony and are fed exceptional high protein, low fat rodent diets; no dog food is ever used. Additionally, all mice are flash frozen and are separate in the bag, not frozen together. I also have ultra low shipping prices to most areas of the U.S. and can beat others shipping prices considerably. I specialize in the smaller mice sizes and currently have the following four sizes available: Small pink mice (1 day old—1 gm) , $25 /100; Large pink mice (4 to 5 days old—2 to 3 gm), $27.50 /100; Small fuzzy mice (7 to 8 days old—5 to 6 gm), $30/100; Large fuzzy mice / hoppers (10 to 12 days old—8 to 10 gm), $35/100 Contact Kelly Haller at 785-224-7291 or by e-mail at kelhal56@hotmail.com

Herp tours: **Costa Rica herping adventures**. Join a small group of fellow herpers for 7 herp-filled days. We find all types of herps, mammals, birds and insects, but our target is snakes. We average 52 per trip, and this is our 10th year doing it. If you would like to enjoy finding herps in the wild and sleep in a bed at night with air-conditioning, hot water and only unpack your suitcase once, instead of daily, then this is the place to do it. Go to our web-site <http:// hiss-n-things.com> and read the highlights of our trips. Read the statistics of each trip and visit the link showing photos of the 40 different species we have found along the way. E-mail at jim.kavney@gmail.com or call Jim Kavney, 305-664-2881.

NEW CHS MEMBERS THIS MONTH

Jennifer Berlinghof
Charlotte Every
Dan Keyler
Irene Lutton
Erik Maki
Adrae Nunez
April Proksa
Kelly Turner
Regina Waldroup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Email: zoomed@zoomed.com
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UPCOMING MEETINGS

The next meeting of the Chicago Herpetological Society will be held at 7:30 P.M., Wednesday, March 27, at the Peggy Notebaert Nature Museum, Cannon Drive and Fullerton Parkway, in Chicago. **Stephen Barten, DVM**, will speak about "Snake Road: Herping Hotspot." Steve is a past president of the CHS, a veterinarian, and a consummate wildlife photographer. Snake Road is a unique ecosystem in the Shawnee National Forest of southern Illinois that consists of towering limestone bluffs bordered by hardwood forest and buttonwood swamps. A narrow gravel road parallels the bluffs at their base. So many snakes cross the road on their way to and from their hibernacula in the bluffs that the USDA Forest Service closes the road for two months both in the spring and fall to protect the snakes from vehicular traffic. The 2.7-mile closed section is open to foot traffic, and herpetologists and field herpers flock to the area to observe the phenomenon. In his image-heavy presentation Steve will describe the experience, the snakes, and some of the other wildlife that may be encountered.

The speaker at the April 24 meeting will be **Chris Lechowicz**, director of the Wildlife & Habitat Management Program and staff herpetologist at the Sanibel Captiva Conservation Foundation (SCCF) in Sanibel, Florida. Like our March speaker, Chris is a long-time member and past president of the CHS. His program is entitled "SCCF Pine Island Sound Eastern Indigo Snake Project: Current Challenges."

The regular monthly meetings of the Chicago Herpetological Society take place at Chicago's newest museum—the **Peggy Notebaert Nature Museum**. This beautiful building is at Fullerton Parkway and Cannon Drive, directly across Fullerton from the Lincoln Park Zoo. Meetings are held the last Wednesday of each month, from 7:30 P.M. through 9:30 P.M. Parking is free on Cannon Drive. A plethora of CTA buses stop nearby.

Board of Directors Meeting

Are you interested in how the decisions are made that determine how the Chicago Herpetological Society runs? And would you like to have input into those decisions? If so, mark your calendar for the next board meeting, to take place at 7:30 P.M., April 19, 2019, at Papa Passero's Pizzeria, 6326 S. Cass Ave., Westmont..

The Chicago Turtle Club

The monthly meetings of the Chicago Turtle Club are informal; questions, children and animals are welcome. Meetings normally take place at the North Park Village Nature Center, 5801 N. Pulaski, in Chicago. Parking is free. For more info visit the group's Facebook page.

CHS AWARDS PRESENTATION

Each year the Chicago Herpetological Society recognizes a few select members for their service to the organization. At the February 27 meeting awards were presented in two categories. **Gail Oomens** received the CHS Merit Award. This honor is given each year to one or more individuals selected by the Awards Committee for outstanding service to the society. **Kim Klisiak** received the Presidential Service Award, presented each year to a person selected by the president as having been particularly helpful to the president or to the CHS Board. Both these women contribute much to the success of the CHS. It's a pleasure to recognize their efforts. If you see them, say thanks!

THE ADVENTURES OF SPOT

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